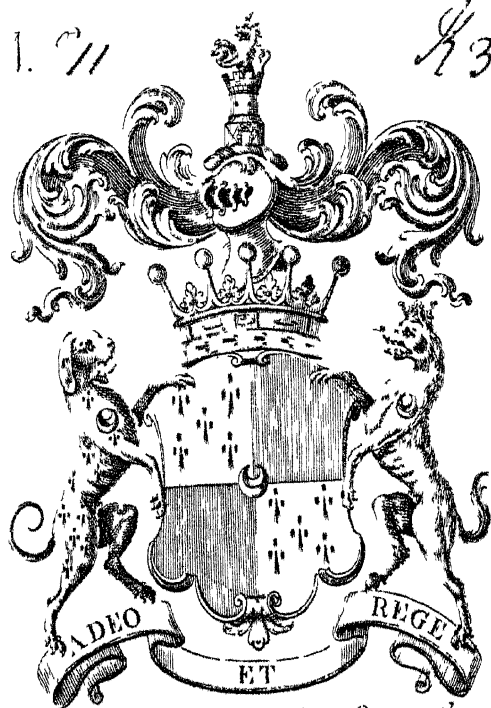


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Philip Earl Stanhope

PHILOSOPHICAL
TRANSACTIONS.

GIVING SOME

ACCOUNT

OF THE

Present Undertakings, Studies, and Labours

OF THE

INGENIOUS,

IN MANY

Considerable Parts of the WORLD.

VOL. XXXVI. For the Years 1729, 1730.

L O N D O N:

Printed for W. INNYS, *Printer to the Royal Society,*
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TO
Sir *HANS SLOANE*, Bart.
PRESIDENT,

AND TO THE
COUNCIL and FELLOWS
OF THE

ROYAL SOCIETY

Of *LONDON*, for
Improving Natural Knowledge,

This Thirty-sixth VOLUME of
Philosophical Transactions
is humbly Dedicated

BY
Their most Devoted,
And most Obliged Servant,

CROMWELL MORTIMER, *R.S. Secr.*

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *January* and *February* 1729.

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- I. *A Catalogue of the fifty Plants from Chelsea-Garden, presented to the Royal Society, by the Company of Apothecaries, for the Year 1727, pursuant to the Direction of Sir Hans Sloane, Bart. Med. Reg. Præs. Col. R. Med. & Soc. Reg. by Isaac Rand Apothecary, F. R. S.*

- 251 **A** Cetosa Ocimi folio, Neapolitana, C. B. 114.
 252 Acetosa vesicaria peregrina Hort. Eyst. .
 253 Alcea afra, frutescens, folio Grossulariæ; flore parvo rubro Boerh. Ind. alt. 271.
 254 Alcea Afra, frutescens, Grossulariæ folio ampliore; unguibus florum atro rubentibus.
 255 Alchimilla montana minima Colum Ecphr. 146.
 256 Althæa frutescens, folio acuto; parvo flore, C. B. 316.
 257 Althæa frutescens, Bryoniæ folio. C B. ib.
 258 Althæa arborea, folio amplo, ferrato.
 259 Althæa Dioscoridis & Plinii. C. B. 315.
 260 Althæa Dioscoridis & Plinii, folio magis angulato T. Inst. 97.
 261 Ambrosia gigantea, inodora; foliis asperis trifidis Banist. Cat. Raii Hist. ap. 1928.
 262 Asperugo vulgaris. T. Inst. 135.
 263 Barba Jovis, Caroliniana, arborescens; Pseudoacaciæ foliis, *Bastard Indigo*, incolis.
 264 Carlina patula, Attractylidis folio & facie. T. Inst. 500.
 265 Centaurium foliis Cynaræ Cornut. 72. .
 266 Circæa Lutetiana Lob. icon. 266.
 267 Circæa minima. Colum. Ecphr. 80.
 268 Conyza Africana, frutescens; foliis Salviæ; odore Camphoræ. T. Inst. 455.
 B. 269, Eli-

- 269 *Elichrysum montanum*, longiore & folio & flore purpureo. T. Inst. 453.
- 270 *Eupatorium Valerianoides*, Triffaginis folio, absq; pediculis, Virginianum. Pluk. Phyt. Tab. 88. f. 4.
- 271 *Glycyrrhiza capite echinato*. C. B. 352.
- 272 *Gramen dactylon*, majus; panicula longa; spicis plurimis nudis crassis. Sloane, Hist. v. i. 112 Tab. 69. f. 2.
- 273 *Gramen dactylon*, paniculâ longâ; è spicis plurimis gracilioribus, purpureis mollibus constante. Sloane, Hist. v. i. 113. Tab. 70. f. 2.
- 274 *Heliotropium Americanum*, cæruleum; foliis Hormini. Dodart. Mem. 83.
- 275 *Heliotropium majus* Dioscoridi. C. B. 253.
- 276 *Jacea* cum squamis pennatis, five capite villoso. I. B. 3. 28.
- 277 *Ketmia Syrorum* quibusdam. C. B. 316.
- 278 *Linaria capillaceo folio*. C. B. 213.
- 279 *Linaria cærulea*, foliis brevioribus & angustioribus. Raii. Syn. Ed. 3. 282.
- 280 *Perficaria mitis*. J. B. 3. 779.
- 281 *Perficaria mitis major*; foliis pallidioribus. D. B. bart. Raii. Syn. Ed. 2. 58.
- 282 *Perficaria orientalis*, Nicotianæ folio; calyce florum purpureo. T. Cor. 38.
- 283 *Perfoliata* vulgarissima five arvensis. C. B. 277.
- 284 *Portulaca Corassavica* procumbens; Capparidis folio; flore muscoso; capsula bifurcata. Parad. Bat. 213.
- 285 *Ranunculus hirsutus*, annuus; flore minimo. Raii Syn. Ed. 2. 135.

- 286 Ricinus minor Staphys agriæ folio ; flore pentapetalo purpureo Sloane Hist. Vol. I. 129. Tab. 82.
 287 Sonchus lævis in plurimas & tenuissimas lacinias divisus. C. B. 124.
 288 Spinacia Cretica, supina ; capsulâ feminis aculeata T. Inst. 533.
 289 Sena spuria, arborea, spinosa ; foliis alatis ramosis seu decompositis ; flore ex luteo & rubro specioso. Sloane Hist. v. ii. 49.
 290 Santolina foliis teretibus. T. Inst. 460.
 291 Santolina repens & canescens. ib.
 292 Santolina foliis minus incanis. T. Inst. 461.
 293 ~~Santolina foliis obscure virentibus.~~ ib.
 294 Santolina vermiculata Cretica. ib.
 295 Santolina incana ; Chamæmeli odore suaviore Boerh. Ind. alt. 123.
 296 Santolina tota viridis ; foliis Ericæ aut Sabinæ. an 3 *Dodon.* 269 ?
 297 Santolina canescens foliis Cupressi. an 4 *Dodon.* ibi
 298 Santolina minor candidissima.
 299 Tithymalus erectus acris ; Parietariæ foliis glabris ; floribus ad caulium nodos conglomeratis. Sloane Hist. v. i. 197. Tab. 126.
 300 Tormentilla reptans, alata, foliis profundius serratis D. Plot. Raii Syn. Ed. 2. 142.

E R R A T A.

IN Philos. Transact. N°. 399, some Mistakes of the Press in the Catalogue of the fifty Plants ought to be thus corrected. Pag. 293, after 203 and 206, dele this Mark — Pag. 294, after the following Numbers, 213, 214, 217, 218, 219, 220, 222, 225, dele — Pag. 295, after the following Numbers, 236, 237, 244, 246, 248, dele —

II. *An Account of the first Decade of a Book, Intituled, Johannis Martyn Historia Plantarum rariorum. Printed at London ; by Richard Reily, 1728. by Mr. Rand, F. R. S.*

MR. *Martyn* in this Work has had the Plants, of their natural Bigness, exactly designed after the Life, and with great Accuracy and Success printed in their proper Colours. This curious Invention was never more aptly applied, though I think this is the first time it has been used in *Botany*. By this Means, without a long tedious Description, a Plant may be known by meer Inspection. However, that nothing may be wanting, the Author has thought fit to give short Descriptions, insisting more particularly on those minute Parts which cannot be so clearly expressed by Sculpture ; and has added, where they could be obtain'd, some Account of their Uses, &c.

The Plant in the first Table he calls *Falapa Officinarum*.

The *Falapa* Root has been in common Use above a hundred Years ; yet the Plant it self wholly unknown to us in *Europe* till P. *Plumier* and M. *Lignon*, who had both passed a considerable Time in *America* in Botanical Disquisitions, at their Return, severally assured Mr. *Tournefort*, that it was a Species of the Plant commonly known by the Name of *Marvel* of *Peru* ; who thereupon thought fit to make *Falapa* the Name of the Genus, and distinguish that of the Shops by the Seeds being more rugose than those of the common.

- Tab. 2. Shows the *Geranium Africanum*, *Arbore-
scens*, *Malvæ folio, lucido; flore elegantis-
simo Kermesino Domini van Leur. Boerb.
Ind. alt. 262.*
3. *Geranium Chium*, *vernum; Caryophyllatæ
folio T. Cor. 20.*
4. *Brunella Caroliniana*, *magno flore, dilutè
cæruleo, internodiis prælongis, Phil. Transf.
No. 395. Pag. 125.*
5. *Amaranthus Sinenfis foliis variis; panicu-
lâ eleganter plumoso.*
6. *Amaranthus spicâ albescente habitiore.*
7. *Parietaria Orientalis, Polygoni folio ca-
nescente T. Cor. 38.*
8. *Niruri Barbadiense, folio Ovali subtus glau-
co, pediculis florum brevissimis, Phil.
Transf. No. 399. Pag. 295.*
- This is of the same Genus with that called
*Niruri, Hort. Malab. Tom. x. and there
described, p. 53. Ours is a much smaller
Plant, the Leaves are less, and grow much
closer on the Stalks, and the Pedicle of each
Flower by two thirds shorter.*
9. *Lychnidea Caroliniana floribus Umbellatim
dispositis, foliis lucidis crassis. This
Plant is something like Lychnidea Virgi-
niana Holostei ampliore folio, floribus
umbellatis purpureis Phil. Transf. No. 395.
Pag. 126. but the Leaves are much larger,
thicker, and of a deep shining green Colour.*
10. *Aloe Africana, foliis planis, conjugatis,
carinatis verrucosis, caule & flore Co-
rallii colore Boerb. Ind. alt. p. 2. Pag. 131.*

The ingenious Author proposes, in the Sequel of this Work, to give an Account of new Plants only, or at least such as have not been well figured by others : If he proceeds with the same Exactness, as I don't doubt he will, the Work very well deserves Encouragement ; for of Plants thus figured and described, there can be no future Doubts.

Happy had it been for us, had the Antients left such Types or Descriptions of those they recommended as considerable for their Use in Medicine. This would have saved the Learned World much Labour and Study in an Enquiry, which 'tis to be feared, for want of such Helps, will prove unsuccessful.

III. *An Attempt to solve the Phenomenon of the Rise of Vapours, Formation of Clouds and Descent of Rain. In a Letter from Dr. J. T. Desaguliers, L. L. D. F. R. S. to Dr. Rutton, R. S. Sec.*

S I R,

THE Reason of my writing upon a Subject which has been so often treated of, is, that none of the Accounts hitherto given of this *Phænomenon* (at least that I have met with) seem to me sufficient to solve all the Circumstances of it.

Dr. *Nieuwentijt* and some others say — That Particles of Fire separated from the Sun-Beams, by adhering to Particles of Water, make up *Molecules*, or small Bodies specifically lighter than Air, which therefore, by hydrostatical Laws, must rise and form Clouds that remain suspended when they are risen up to such an
Height

Height that the Air about them is of the same specific Gravity with themselves. —

That Rain is produced by the Separation of the Particles of Fire from those of Water, which last being then restored to their former specific Gravity, can no longer be sustained by the Air, but must fall in Drops. See *Nieuwentyt's Religious Philosopher*. Contemplation 19. From Sect. xiii. to Sect. xxv.

Now this is liable to several Objections, *First*, It is built upon a Supposition that Fire is a particular Substance, or distinct Element, which has never yet been prov'd by convincing Experiments and sufficient Observations; and which the Reverend Mr. *Hales* has in his late excellent Book of *Vegetable Statics* shewn to be an ill grounded Opinion, making it very plain, that in Chymical Operations those Bodies which had been thought to become heavier by Particles of Fire adhering to them, were only so by Adhesion of Particles of Air, &c. which he has shewn to be *absorbed* in great Quantities, by some Bodies, whilst it is *generated* (or reduced from a fixt to an elastick State) by others; nay, that it may be *absorbed* and *generated* successively by the same Body, under different Circumstances.

Secondly, If we should allow the above-mentioned Supposition, the Difficulty will still remain about the Production of Rain by the Separation of the Fire from the Water; For Dr. *Nieuwentyt* ascribes this Effect to two different Causes. *First*, to Condensation (*Sect.* xxiii.) Saying, "That when contrary Winds blow
" against the same Cloud and drive the watery Particles together, the Fire that adhered to them gets
" loose, and they (becoming then specifically heavier)
" precipitate and fall down in Rain". Then in the
very

very next *Señ.* he ascribes it to Rarefaction, when he says, "That when a Wind blowing obliquely upwards causes a Cloud to rise into a thinner Air (*i. e.* specifically lighter than it self) the Fire which by sticking to the Particles of Water rendered them lighter, extricates it self from them, and ascending by its Lightness, the Water will become too heavy, not only to remain in this thin and light Air, but even in a thicker and heavier near the Earth, and so will be turned into a descending Dew, Mist, or Rain, or Snow, or the like, according as the watery Vapours are either rarefied or compressed".

The first of these Causes of Rain is contrary to Experience; for when two contrary Winds blow against each other over any Place of the Earth, the Barometer always rises, and we have fair Weather. For then (as *Dr. Halley* says, in *Philosophical Trans.* No. 183) the Air being accumulated above, becomes specifically heavier about the Clouds, which (instead of falling into Rain, as *Dr. Niewentyt* supposes) ascend up into such a Part of the Atmosphere, as has the Air of the same specifick Gravity with themselves.

If the falling of Rain might be attributed to the second of these Causes, then every time a Cloud is encompassed with Air specifically lighter than it self (whether it be when by the blowing away some of the superior Air, that which is about the Cloud becomes rarer as it is less compressed, or by the Cloud being driven upwards) Rain must necessarily follow; whereas one may often see the Clouds rise and fall without Rain, even when the Barometer shews the Weight of the Air to be alter'd. For that happens only when by the great Diminution of the specifick Gravity of the Air about
the

the Cloud, it has a great Way to fall ; in which Case, the Resistance of the Air, which increases as the Square of the Velocity of the descending Cloud, causes the floating Particles of Water to come within the Power of each others Attraction, and form such big Drops, as being specifically heavier than any Air, must fall in Rain.

No gentle Descent of a Cloud, but only an accelerated Motion downwards, produces Rain.

N. B. *I don't mean that the quick Descent of a Cloud is the only Cause of Rain; because the Shock from a Flash of Lightning, and the sudden return of the Air, after the Vacuum made by the Flash, will condense the floating Vapour into Water; and also the same Cloud which in the free Air, might be carried horizontally without being turned into Rain, meeting with an high Hill in its Way, will be condensed and fall in Drops; especially if, in the Day-time, it be driven by the Wind out of the Sunshine, against the shaded Side of the Mountain.*

Besides all this, if Particles of Fire were joined with those of Water to raise them up, those igneous Particles must be at least 1000 Times greater in Bulk than the watry ones; so that a Person, who at the Top of a Hill, has his Hands and Face in a Cloud, must feel a very sensible Warmth, by touching a much greater Surface of Fire than Water in the Cloud, and afterwards find the Rain produced from that Vapour sensibly colder; whereas the contrary is proved by our Senses; the Tops of Hills, tho in the Clouds, being much colder than the Rain Bottom.

There is another Opinion concerning the Rise of Vapours, namely, that tho' Water be specifically heavier than Air, yet if its Surface be encreased by very much diminishing the Bulk of its Particles, when once raised, it cannot easily fall ; because the Weight of each Particle diminishes as the Cube Root of its Diameter, and the Surface to which the Air resists, only as the Square Root of the said Diameter : That we see this in the Dust in Summer, and in Menstruums that sustain Metals dissolved, which are specifically heavier than the Menstruums.

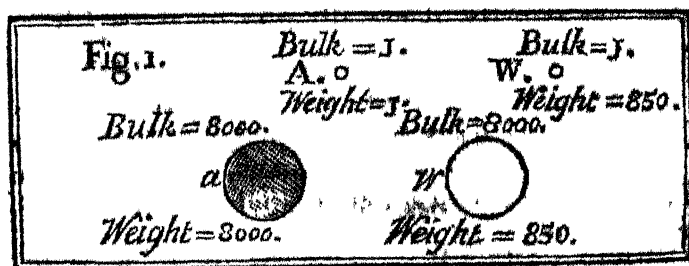
But this will not explain the *Phænomenon* ; because though the Encrease of Surface (the Weight remaining the same) will in a great Measure hinder (or rather retard) the Descent of small Bodies moving in the Air, by reason of its great Resistance to so large a Surface ; it will for the same Reason also hinder the Ascent. For the Rise of Dust is owing to the Motion of Animals Feet in it, or to the Wind : Whereas Vapours rise in calm Weather, as well as windy ; neither do they, like the Dust, always fall to the Ground when the Wind ceases to blow.

The third Opinion, and which is most commonly received, is, that by the Action of the Sun on the Water, small Particles of Water are formed into hollow Spherules filled with an *Aura*, or finer Air highly rarefied, so as to become specifically lighter than common Air, and consequently that they must rise in it by hydrostatical Laws. As for Example, If a Particle of Water, as it becomes a hollow Sphere, be only encreased ten Times in Diameter, its Bulk will be encreased a thousand Times ; there-

(II)

fore it will then be specifically lighter than common Water, whose specifick Gravity is to that of Air, as 850 to 1; then if the Density of the *Aura*, or Spirit within the little Shell, be supposed 9 Times less than that of Air, or as 50 to 850, that specifick Gravity of the Shell, and its Contents will be to that of Air, as 900 to 1000; therefore such an aqueous Bubble must rise till it comes to an *Æquilibrium* in Air, whose Density is to the Density of that in which it began to rise, as 850 to 945 nearly. But it appears by Experiments, that Air rarefied by an Heat which makes a Retort red hot, is only encreased in Bulk, or dilated 3 Times, by the Heat of boiling Water only $\frac{1}{3}$ or near two Thirds; and by the Heat of the Humane Body (such as will raise Vapours plentifully) only $\frac{1}{3}$ or about $\frac{1}{3}$. I own my Objection may be answered, by supposing the Spherule of Water to be more encreased in Diameter, as for Example 20 Times; because then if it be filled with Air only $\frac{1}{2}$ rarer than common Air, it will be specifically lighter, and capable of rising to a considerable Height.

To give this Solution all its Force, let us express it in Numbers. Let A and W (Fig. 1.) represent



a Particle of Air, and one of Water of equal Bulk, then will the Weight of A be to the Weight of W as 1 to 850, their Bulks being equal. If the Particle of Water be blown up into a Bubble (w) of 20 Times its Diameter, then will its Bulk be to its Weight, as 8000 to 850, whilst a Sphere of Air (a) of the same Bigness, has its Weight as well as Bulk equal to 8000: Now if an Air or *Aura* rarer than common Air be supposed within the watry Bubble to keep it blown, it will be the same as if $\frac{1}{2}$ of the Air of (a) was carried into (w) and then the Weight of (w) would be increased by the Number 6000; so that the Shell of Water being in Bulk 8000, would be in Weight $850 + 6000 = 6850$, whilst an equal Bulk of Air weighed 8000, and consequently the watry Bubble would rise till it came to an Air, whose Density is to the Density of the Air next to the Surface of the exhaling Water as 6850 to 8000.

This is the strongest Way of stating the Hypothesis. But to support it, the following Queries must be answered.

Query 1st, How comes the *Aura*, or Air in the Bubbles, to be specifically lighter than the Air without them, since the Sun's Rays, which act upon the Water, are equally dense all over its Surface?

Query 2d, If it could be possible for a rarer Air to be separated from the denser ambient Air, to blow up the Bubbles (as Bubbles of soaped Water are blown up by warm Air from the Lungs, whilst the ambient Air is colder and denser) what would hinder that cold Air by its greater Pressure, from reducing the

the Bubbles to a less Bulk, and greater specifick Gravity than the Air, especially since Cold can be communicated through such thin Shells, and the Tenacity of common Water is very small when compared to that of soaped Water (whose Bubbles, notwithstanding that Tenacity) are soon destroyed by the Pressure of the outward Air, as the Air within them cools?

Query 3d, If we should grant all the rest of the Supposition, yet this Difficulty will remain. If Clouds are made up of hollow Shells of Water filled with Air, why do not those Clouds always expand when ~~the ambient Air is rarefied, and presses less~~ than it did before, and also suffer a Condensation, as the ambient Air is condensed by the Accumulation of the superiour Air?

If this Condensation and Rarefaction should happen to the Clouds, they would always continue at the same Height, contrary to Observation; and we shou'd never have any Rain. *

From all this it follows, that the Condensation and Rarefaction of the Vapours, which make Clouds, must depend upon another Principle than the Condensation and Rarefaction of the Air: And that there is such a Principle, I shall endeavour to shew.

L E M M A.

The Particles of all Fluids have a repellent Force

FLUIDS are elastick or unelastick: The elastick Fluids have their Density proportionable to their Compression, and Sir *Isaac Newton* has demonstrated (*Princip. Lib. ii. Sect. v.*) that they consist of Parts that repel each other from their respective Centers. Unelastick Fluids, like Mercury, Water and other Liquors, are by Experiments found to be incompressible; for Water in the *Florentine Experiment* could not by any Force be compressed into less Room, but ooz'd like Dew through the Pores of the hollow golden Ball in which it was confined, when a Force was apply'd to press the Ball out of its spherical, into a less capacious Figure. Now this Property of Water and other Liquors must be intirely owing to the centrifugal Force of its Parts, and not its want of Vacuity; since Salts may be imbib'd by Water without encreasing its Bulk, as appears by the Encrease of its specifick Gravity. So Metals, which (singly) have a certain specifick Gravity beyond which they cannot be condens'd, will yet receive each other in their Interstices so as to make a Compound specifically heavier than the heaviest of them; as is experienced in the Mixture of Copper and Tin.

SCHOLIUM.

By encreasing the repellent Force of the Particles, an unelastick or incompressible Fluid may become elastick, or a Solid (at least a great Part of it) may be changed into an elastick Fluid; and, *vice versâ*, by diminishing the repellent Force, an elastick Fluid may be reduc'd to an unelastick Fluid, or to a Solid. That the Particles of Quicksilver, Water and other Liquors are likewise endued with an attractive Force, is evident from those Substances running into Drops in an exhausted Receiver, as well as in the Air, and likewise their adhering to other Bodies. The Attraction and Repulsion exert their Forces differently: The Attraction only acts upon the Particles, which are in Contact, or very near it; in which Case it overcomes the Repulsion so far, as to render that Fluid unelastick, which otherwise would be so; but it does not wholly destroy the Repulsion of the Parts of the Fluid, because it is on Account of that Repulsion that the Fluid is then incompressible. When by Heat or Fermentation (or any other Cause, if there be any) the Particles are separated from their Contact, the Repulsion grows stronger, and the Particles exert that Force at great Distances, so that the same Body shall be expanded into a very large Space by becoming fluid, and may sometimes take up more than a Million of Times more Room than it did in a solid or incompressible Fluid. (See the *Queries* at the End of Sir *Isaac Newton's Opticks*.) Thus is Water
by

by boiling, and less Degrees of Heat, changed into an elastick Vapour rare enough to rise in Air, Oils and Quicksilver in Distillation made to rise in a very rare Medium, such as remains in the red-hot Retort, and sulphureous Steams will rise even in an exhausted Receiver, as the Matter of the *Aurora Borealis* does in the thinner Part of our Atmosphere. If Aqua-fortis be poured on Quicksilver, a reddish Fume will rise much lighter than common Air; so also will Fumes rise from Filings of Metals, from Vegetables when they ferment by Putrefaction; and (as the Reverend Mr. *Hales* has shown) several solid Substances by distilling, as well as Fermentation, will generate permanent Air.

That Heat will add Elasticity to Fluids is evident from numberless Experiments, especially from Distilling and Chymistry: But what is needful to consider here is only, that it acts more powerfully on Water than common Air; for the same Heat which rarefies Air only; will rarefy Water very near 14000 times, changing it into Steam or Vapour as it boils it: And in Winter, that small Degree of Heat, which in Respect to our Bodies appears cold, will raise a Steam or Vapour from Water at the same Time that it condenses Air

By a great many Observations made by Mr. *Henry Beighton*, F. R. S. and my self, upon the Engine to raise Water by Fire, according to Mr. *Newcomen's* Improvement of it; we found that the Water in boiling is expanded 14000 times to generate a Steam as strong (*i. e.* as elastick) as common Air, which therefore must be near 16 $\frac{1}{2}$ times specifically

cifically lighter. And that this Steam is not made of the Air extricated out of the Water is plain, because it is condens'd again into Water by a Jet of cold Water spouting in it ; and the little Quantity of Air that comes out of the injected Water must be discharged at every Stroke, otherwise the Engine will not work well. There is also another Experiment to confirm this.

EXPERIMENT.

ABCD is a pretty large Vessel of Water, which must be set upon the Fire to boil. In this Vessel must be suspended the glass Bell E, made heavy enough to sink in Water ; but put in, in such a Manner that it be filled with Water when upright, without any Bubbles of Air at its Crown within, the Crown being all under Water. As the Water boils, the Bell will by Degrees be emptied of its Water, being press'd down by the Steam which rises above the Water in the Bell ; but as that Steam has the Appearance of Air, in order to know whether it be Air or not, take the Vessel off the Fire, and draw up the Bell by a String fasten'd to its Knob at Top, till only the Mouth remains under Water ; then, as the Steam condenses by the cold Air on the outside of the Bell, the Water will rise up into the Bell at F quite to the Top, without any Bubble above it, which shews that the Steam which kept out the Water was not Air.

N. B. *This Experiment succeeds best when the Water has been first purg'd of Air by boiling, and the Air-Pump.*

We know by several Experiments made on the Fire-Engine (in Captain Savery's Way, where the

Steam is made to press immediately on the Water) that Steam will drive away Air, and that in Proportion to its Heat; though in the open Air it floats and rises in it like Smoak.

Now if the Particles of Water turn'd into Steam or Vapour repel each other strongly, and repel Air more than they repel each other; Aggregates of such Particles made up of Vapour and Vacuity may rise in Air of different Densities, according to their own Density dependant on their Degree of Heat, without having Recourse to imaginary Bubbles form'd in a Manner only supposed, and not proved, as we have already shewn. *I own indeed, that if the watry Particles had no repellent Force, they must precipitate in the same Manner that Dust will do after it has been raised up; but we have too many Observations and Experiments to leave any Doubt of the Existence of the repellent Force above-mentioned. Neither can I shew by any Experiment, how big the Molecuæ of Vapour must be which exclude Air from their Interstices, and whether those Molecuæ do vary in Proportion to the Degree of Heat by an Increase of repellent Force in each watry Particle, or by a farther Division of the Particles into other Particles still less; but in general we may reasonably affirm, that the Rarity of the Vapour is proportionable to the Degree of its Heat, as it happens in other Fluids (See Phil. Transact. Numb. 270.) and that, though the different Degrees of the Air's Rarefaction are also proportionable to the Heat; the same Degree of Heat rarefies Vapour much more than Air.*

Now to shew, that what has been said will account for the Rise of Vapours and Formation of Clouds,

Clouds, we must only consider; — whether that Degree of Heat; which is known to rarefy Water 14000 * Times, being compared with several of those Degrees of Heat in Summer, Autumn and Winter, which are capable of raising Exhalations from Water or Ice; the Rarity of the Vapours (estimated by the Degree of Heat) will appear to be such, that the Vapour will rise high enough in Winter, and not too high in Summer, to agree with the known *Phænomena*.

That the Effects are adequate to the Causes in this Case, I think I can make out in the following Manner, viz.

The Heat of boiling Water, according to Sir Isaac Newton's Table (*Phil. Transact.* Num. 270) is 34, the mean Heat of Summer 5, the mean Heat of Spring or Autumn 3, and the least Degree of Heat, at which Vapours rise in Winter (*alias* the mean Heat of Winter) is 2. The Rarity of Vapour proportionable to these four Degrees of Heat, is 14000, 2058, 1235, and 823. The Rarity of Air is, in Summer 900, in Spring or Autumn 850, and in Winter 800, the Density of Water compared with the above-mentioned Densities, being inversely as *One* to the said fore-mentioned four Numbers. The Heights above the Earth to which the Vapours will rise, and at which they will be in *æquilíbrio*, in an Air of the same Density with themselves, will vary according to the Rarity of the Vapour depending on the Heat of the Sea-

* As the Digression wou'd be too long to mention here those Observations on the Fire-Engine, which shew that the Vapour from boiling Water is expanded 14000 Times more than cold Water; I refer the Reader to the 6th Section of 25th Contemplation of Niewentyt's Religious Philosopher, where he proves by an Experiment made with an *Æolipile*, that one Inch of Water produces 13365 Inches of Vapour; which, considering the great Allowances made against the Assertion, may well be call'd 14000.

son. For the Vapour which is raised by the Winter's Heat, expressed by the Number 2, when the Air's Rarity is 800, will rise to (and settle at) an Height of about the Sixth of a Mile, when the Barometer is above 30 Inches high. But if the Heat be greater then, the Vapours will rise higher, and pretty much higher if the Sun shines, though in frosty Weather, the Barometer being then very high. If the Barometer falls, and thereby brings the Place of *Æquilibrium* (for Vapours raised by the Heat 2) nearer the Earth, then also will the Heat be increased, the Vapour more rarefied, and consequently the new Place of *Æquilibrium* sufficiently high. It is to be observed, that in Winter, when the Heat is only equal to 2, the Air is densest close to the Earth, which has not any Heat sufficient to rarefy it near the Ground, as happens in warm Weather; therefore the Vapour will rise gradually in an Air whose Density decreases continually from the Earth upwards; neither will the Vapour be hindered of its full Rise, by any Condensation from a greater Cold of the ambient Air, the Air being then as cold next to the Ground where the Vapour begins to rise, as it is at any Height from the Earth.

The Vapour which is raised by the Heat of Spring or Autumn expressed by Number 3, will rise to the Height of $3\frac{1}{2}$ Miles, when the Barometer is at 30, and the Air's Rarity is 850. But then, as the Air is hotter nearer the Ground than at the Height of half a Mile or a Mile, the Vapour will condense as it rises; and as the Air, when the Earth is heated, is rarer near the Ground than at some Height from it, the Place of *Æquilibrium* for Vapour will, upon these

these two Accounts, be brought much lower than otherwise it would be ; as for Example, to the Height of about a Mile, which will agree with *Phænomena*.

In Summer, the two Causes above-mentioned encreasing, the Vapour raised by the Heat γ (whose Place of *Æquilibrium* would be $\gamma\frac{1}{7}$ Miles high, if the Vapour after it began to rise was not condensed by cooling, and the Air was densest close to the Earth) will settle at the Height of about $1\frac{1}{2}$ or 2 Miles, which is also agreeable to *Phænomena*.

Lastly, As the Density and Rarity of the Vapour is chiefly owing to its Degree of Heat, and in a small Measure to the encreased or diminished Pressure of the circumambient Air, when it is not confined ; and the Density and Rarity of the Air is chiefly owing to the increased or diminished Pressure, by the Accumulation or Exhaustion of superior Air, whilst Heat and Cold alter its Density in a much less Proportion ; the Clouds made of the Vapours above-mentioned, instead of conforming themselves to the altered Density of the ambient Air, will rise when it is condensed, and sink when it is rarefied ; and also rise or sink (when the Pressure of the Air is not altered, and its Density very little changed) by their own Dilatation, owing to Heat or Cold ; as may be observed often, by seeing them change their Height considerably, whilst the Barometer continues exactly at the same Degree, and the Thermometer's Liquor rises or falls very little, and sometimes not at all.

As for the Manner how Clouds are changed into Rain, I have hinted it in the Beginning of this Paper ; but for farther Satisfaction, I refer the Reader

to Dr. *Halley's* Account of it, in the *Philosophical Transactions* (Numb. 183.) in which I entirely acquiesce, having always found it agreeable to the *Phænomena*.

If by publishing these Thoughts, I have explained the Rise of Vapours, in a more satisfactory Way than has been done before; or if I have only given useful Hints to others more capable of doing it, I have my End.

P. S. Since I have, for Brevity sake, only mentioned at what Heights from the Surface of the Earth, Vapours of different Densities will come to an *Æquilibrium*, without giving a Reason for settling the Place of *Æquilibrium*, at those Heights; I think proper to give the Method here by which they are to be found, *viz.* As the Vapours will settle and rise where the Air is of the same Density with themselves, it is only required to find the Density of the Air at any Distance from the Earth, at several Heights of the Barometer, which may be deduced from Dr. *Halley's* two Tables, *Philosoph. Transact.* Num. 386. (the First shewing the Altitude to given Heights of the Mercury, and the Second the Heights of the Mercury at given Altitudes) and knowing the Degree of Heat by the Thermometer, because the Density of the Vapour depends upon the Degree of Heat of the Season; provided that proper Allowances be made for the great Rarefaction of the Air near the Earth in hot and dry Weather, and the Condensation of the Vapours in their Rise, by reason of the Air being colder at a little Height above the Earth than just at the Surface of it.

IV. *An Account of some Observations relating to Natural History, made in a Journey to the Peak in Derbyshire, by Mr. J. Martyn, F. R. S.*

THE *Peak* in *Derbyshire*, having hitherto been described in scarce any other Light, than as a Place composed of Wonders; I was not a little desirous to make some Enquiry into the Nature of a Place generally esteemed one of the most Surprising of our own Country.

In my Way thither, I took Notice of the following Plants, which I have not observed to be com-

mon in other Parts of *England*, and are not taken Notice of by the Bishop of *London*, in his Edition of *Cambden*.

Stachys Fuchsi, J. B. In the Road to *Grantham*, a little beyond *Colefworth*.

Scrophularia Scorodonia, folio Mor. At *Wollerton*, under the Garden-wall. This does not owe its Origine in this Place to Seeds, scattered out of the Garden; as I am convinced, by the perusal of a Manuscript Catalogue of the Plants cultivated in that Garden, in which there is no mention made of this Plant.

The *Lychnis*, which grows on *Nottingham-Castle*, is the *Lychnis sylvestris alba* 9 *Clusii*, and not the same with Mr. Ray's *Lychnis major noctiflora Dubrensis perennis*, as he suspected.

Festuca humilior panicula brevi heteromalla. Gramen paniculatum, bromoides, minus, paniculis aristatis, unam partem spectantibus Raii Syn. On *Sherwood Forest*.

Salix folio laureo, seu lato glabro odorato Phyt. Brit. Common about *Wingerworth*.

Ladanium arvense, flore amplo luteo; labro purpureo. Lamium cannabinum, flore amplo luteo, labio purpureo Raii Syn. In the Corn in several Places.

Filix mas non ramosa, pinnulis angustis, raris, profunde dentatis Ger. emac. Common about *Wingerworth*.

The *Peak* is famous for seven Places, which have been dignified by our Ancestors, with the Name of Wonders: 1. *Chatfworth*, a magnificent Seat of his Grace the Duke of *Devonshire*; 2. *Mam-tor*; 3. *Elden-hole*; 4. *The ebbing and flowing Well*; 5. *Bux*.

5. *Buxton-Well* ; 6. *Peak's Hole*, and 7. *Pool's Hole*. The First being a Work, not of Nature, but Art; does not come within the Design of this Account. *Mam-tor* is a huge Precipice facing the East, or South-East ; which is said to be perpetually shivering and throwing down great Stones on a smaller Mountain below it ; and that nevertheless, neither the one increases, nor the other decreases in Bigness. This Mountain is composed chiefly of a Sort of Slate-Stone (called in that Country *Black Shale*) and great Stone. The Nature of the *Black Shale* is known to be, that notwithstanding it is very hard before it is exposed to the Air ; yet it is afterwards very easily crumbled to Dust. Thus on any Storm, or melting of Snow, this Shale is considerably wasted ; and as the great Stones are gradually disengaged, they must necessarily fall down. That it is only at these Times that the Mountain wastes, is affirmed by the most intelligent of the neighbouring Inhabitants : And that this Decay is not perpetual, I can affirm myself ; having not only taken a close Survey of it, but also climbed up the very Precipice, without seeing any other shivering in the Mountain, than what the treading of my own Feet in the loose crumbled Earth occasioned. That the Mountain does not decrease in the mean Time, is a Tale too frivolous to need any Consideration.

Elden-hole, is a huge perpendicular Chasm. The Depth of it is not known. Mr. *Cotton* tells us, that he sounded 884 Yards, and yet the Plummets drew. But he might easily be deceived, unless his Plummets was of a very great Weight ; for otherwise, I imagine the

the Weight of a Rope of that Length, would be so great as to make the Landing of the Plummet scarce perceivable. Be that as it will, the Depth of it is to be sure very considerable; and considering that we have no where in *England* so good an Opportunity of searching the Bowels of the Earth to so great a Depth; I wonder no curious Person has ever had the Courage to venture down. It is said indeed, that a poor Fellow was hired to be let down with a Rope about his Middle, two hundred Yards; and that he was drawn up again, out of his Senses, and died a few Days after: And no Wonder, for the poor Wretch having nothing else to reflect on in that dismal Place, but the Danger he had put himself into for the Sake of a little Money, might probably be fright'ned out of his Senses. Or indeed the very Fatigue itself might put him into that Condition; as any one will easily imagine, who has been let down but a quarter of the Way, and drawn up again in that Manner. But I conceive, that if any intelligent and prudent Person was to be let down in a proper Machine; he would not be much in Danger, and his Fatigue would be very inconsiderable.

The *ebbing and flowing Well* is far from being regular, as some have pretended. It is very seldom seen by the Neighbours themselves; and, for my Part, I waited a good while at it to no Purpose: And so I shall pass it over in Silence.

Buxton-Well has been esteemed a Wonder, on account of two Springs, one warm and the other cold, rising near each other. But the Wonder is now lost, both being blended together. The Spring
E which

which is now used for bathing, appears to be 32 Degrees of one of Mr. *Hawksbee's* Thermometers warmer than the common spring Water there*. Statical Experiments on the Effects of warm bathing, having been seldom made, I hope a few, which I had an Opportunity of making, will not be unacceptable.

		Weight. lb. 3.	After bathing 12 Minutes.	Urine.
<i>July</i> 21. 1728. h. 10 ³ at Night.	A.	137 12	137 11 ¹ / ₂	3 3
	B.	134 15 ¹ / ₂	134 13 ¹ / ₂	
	C.	169 15	170 —	
	D.	119 6 ¹ / ₂	119 7	4 3
			Urine. 3.	Weight after 1 h. 20 Min.
22 h. 8 ² Morning.	A.	136 9	9 ¹ / ₂	135 15
	B.	134 1	7	133 7
	C.	168 13	13	167 11
	D.	118	15	117 —
h. 11. after eat. Cloaths changed.	A.	137 5	After h. 1; Exercise chief- ly un. Ground in <i>Pool's Hole</i> .	
	B.	140 7		
	C.	170 4 ¹ / ₂		
	D.	117 8		
Aft. Din. Cloaths changed.	A.	136 14	3	Perfpiration in 1 ¹ / ₂ h. where note, that it all used moderate Exercise, walk- ing about, except D, who sate still reading the whole time.
	B.	142 6 ¹ / ₂	7 ¹ / ₂	
	C.	170 15	3	
	D.	119 1	6 ¹ / ₂	

* The Spring Water kept the Spirit of Wine at 41, the Bath Water raised it to 8¹/₂.

Servant who at- tended the Bath.	Weight.	Aft. 1 h. bath.	Aft. 1. h. Persp.
	lb 3 173 4	lb 3 173 6	lb 3 172 15

From these Experiments may be concluded,
 1st, That warm bathing increases the Weight of the Body for the present; though it causes a plentiful Perspiration afterwards: Which I do not remember that any one has hitherto observed.

2^{dly}, That the Perspiration after this Exercise is nothing near so large as Dr. *Keill* * has delivered; it amounting by his Account to one Pound and a half in one Hour's Time. By our Observation it is but five Ounces in one Hour, and from eight Ounces and a half to one Pound, in one Hour and a half, though assisted by Motion; which might have caused us to perspire (by Dr. *Keill*'s Computation†) from three to six Ounces.

Peak's Hole and *Pool's Hole* are two remarkable horizontal Openings under Mountains, the one near *Ca-ffleton*, the other just by *Buxton*. They seem to me to have owed their Original to the Springs which have their Current through them. It is easy to imagine that when the Water had forced it's Way through the horizontal Fissures of the *Strata*, and had carried the loose Earth away with it, the loose Stones must of

* Med. Stat. p. 16.

† Calore, motu & exercitio uncia 2 vel 3 interdum 4 perspiratione uni-
us horæ expelluntur. Med. Stat. p. 15.

Course fall down ; and that where the *Strata* had few or no Fissures, they remained entire, and so formed those very irregular Arches which are so much wondered at in these Places. Whether this be the true Origine of these Caves or not, I submit to those who shall hereafter have the Curiosity to examine. It seems more probable to me, than what others have hitherto proposed. The three Rivers, as they are commonly called, in *Peak's Hole* are only some Parts of the Cave deeper than the rest, and receiving all their Water from the Spring which comes from the farther End of the Cave. The Water which passes through *Pool's-hole* is impregnated with Particles of Limestone, and so has incruusted almost the whole Cave in such a Manner, that it appears like one solid Rock.

The more rare Plants which I observed in the *Peak* are,

Scariola sylvestris Anguillara. Lactuca sylv. murorum flore luteo *J. B.* On old Walls and about the Entrance into *Peak's-hole*. It grows also in *Hertfordshire*. I choose to take Notice of it on this Occasion, the rather because *M. Vaillant* has evidently mistaken the Characters of it in his new Distribution of the *Cichoraceous Tribe* in the *Memoirs of the Royal Academy of Sciences* for the Year 1721. He there makes it a Species of *Lactuca*, from which it is very different on his own Principles. According to his Method, the *Empalement* of the *Lactuca* is *squamous*, and the *Down* of the Seed sits upon a *Pedicle*. But this Species has a *simple Empalement* and a *sessile Down*. These Characters evidently distinguish it not only from *Lactuca*, but from every *Genus* in his Method. I shall take leave therefore to constitute a new *Genus* :

And

And as the Name of *Scariola*, by which *Anguillara* has called it, has not yet been appropriated to any other Genus, I shall appropriate it to this, and define it, as follows.

Scariola is a *Cichoraceous Plant*, with a *simple Empalement*, a *naked Placenta*, and *Seeds crowned with a hairy sessile Down*.

Rosa sylv. alba cum aliquo rubore foliis hirsutis J. B. In several Hedges about *Hathersedge*.

Empetrum montanum fructu nigro Tourn. Common on the Mountains.

Oxycoccus, seu Vaccinia palustris, J. B. On boggy Places, but not very common.

Erica humilis cortice cinereo Arbuti flore albo, H. R. Par. On the Mountains near *Hathersedge*.

Rubus Idæus spinosus fructu rubro, J. B. In the Hedges.

Geranium saxatile Ger. *emac.* About the Entrance into *Peak's-hole*.

Cochlearia rotundifolia minima Merr. With the preceeding.

Thalictrum minus Ger. In the same Place.

Lichenoides saxatile, fuscum, pilosum, varie divisum. Corallina fusca foliosa Doody Budd. Hort. *ficc.* On the Rocks.

Lichenoides saxatile tinctorium foliis pilosis purpureis Dillenii. On the Rocks.

Usnea saxatilis, capillacea. Muscus corallinus, saxatilis, fœniculaceus Raii Syn. On the Rocks near *Darwent*.

Lycopodium Sabine facie Fl. Jen. On the Mountains near *Darwent*.

Selago foliis & facie Abietis Fl. Fern. On the Mountains near *Darwent*.

Bryum Hypnoides capitulis, plurimis erectis lanuginosum Dillenii. On the Mountains.

Cardamine impatiens altera hirsutior R. et Syn. About the Mouth of *Pool's-hole* plentifully.

A Variety of Mr. *Ray's Viola montana* later with a blue and yellow Flower.

The *Lead-mines* in *Derbyshire* are very various with regard to their Courses. One into which I went down, had two Branches; one running to the N. E. the other to the N. W. And as I was informed, one of the best they ever discovered ran due North. Their Breadth and Depth are full as irregular. The Bodies through which they dig to come at the Vein are generally *Limestone* and *Black Shale*. But it is uncertain which of the two is uppermost. Of two Mines into which I went down, in one they had dug first through 26 Yards of *Limestone*, then through one of *Black Shale*: In the other first through 42 Yards of *Shale*, and then through 28 of *Limestone*. The Substances which they find mixt with the *Ore*, are

1. *Chert*. This is a kind of *Flint*, which Dr. *Woodward** says is called so, when it is found in thin *Strata*. But in the *Peak* the *Strata* of *Chert* are often four Yards thick, or thicker. They are found in *Limestone*, and not always disposed in *Strata*. Those which I took Notice of were generally either black, or of such a Colour as the inspissated Juice of the *Buck-thorn* Berries, which the Painters call by the Name of *Sap-green*: Whence they are called *Green Cherts* and *Black Cherts*.

* Method of Fossils, p. 21.

2. *Spar*. This is compos'd of *Cryſtal* mixt with other Bodies. Those which they call *Sugar-ſpars*, are those whose Cryſtallifications are very ſmall, and ſo on crumbling to Pieces have the Appearance of powdered Sugar. I have two Sorts of theſe; white and blue. *Dog-tooth Spar* is a white pointed Spar, in Form and Colour ſomething reſembling Teeth.

3. *Cauk*. This Dr. Woodward * ſays is a coarſe talky Spar. But in that Subſtance which I met with in this Country under the Name of *Cauk*; I could not diſcover any Flexibility or Elasticity, which that learned Writer has ſet down as Characteriſticks of *Talk* and *Talky Bodies*. † It ſeems to me to be nothing but *Spar* incorporated with a coarſe earthy Matter. When this *Cauk* is mixt with pellucid Cryſtallifications of *Spar*, it is called Baſtard Cauk.

There are ſeveral other Bodies mixt in the Mines with *Lead-ore*: But as they did not occur in thoſe Mines which I examined, I ſhall omit the Mention of them.

When the *Ore* is brought up from the Mine it is broken to Pieces that the *Spar*, *Cauk*, or other Bodies which adher'd to it may be the more eaſily ſeparated: It is then thrown into a large Sieve and waſhed, and ſo farther purified from extraneous Bodies. After this, it is carried to the Furnace in order to be ſmelted. The Furnace, which I ſaw near *Workſworth*, was very rude and ſimple, conſiſting only of ſome large rough Stones, placed in ſuch a Manner as to form a ſquare Cavity, into which the Ore and Coals are thrown *ſtratum ſuper ſtratum*; two great Bellows continually blowing the Fire, being moved alternately by Water. I ſaw

* Method of Foffils, p. 18. † Catalogue of Foffils, Vol. I. part I. p. 57.

no other Fuel used on this Occasion but dried Sticks, which they call white Coal. * Mr. Ray informs us, that they use both white and black Coal or Charcoal in *Cardiganshire*. I suppose because that Ore is harder to flux; the Charcoal making a more vehement Fire. They generally throw in some Spar along with the Ore, which is thought by imbibing the Sulphur to make it flux more easily. They frequently throw in also some Cowke (or Cinders of Pit-coal) because they think it attracts the Dross, and so makes an easier Separation of it from the Lead. When the Ore is melted, it runs out at an Opening in the Bottom Part of the Front of the Furnace, through a small Channel made for that Purpose, into a cylindrical Vessel, out of which it is laded into the Mould. The Dross of the Ore on smelting is called *Slag*. This *Slag* is afterwards smelted again with Cowke only, and the Lead obtained from it is called *Slag-lead*. Their Way of making *Red-lead* is the same with † Mr. Ray's Account; only they use three Parts of Lead, and one of *Slag-lead*; and think that the *Red-lead* made thus is better than if made without *Slag-lead*.

* Collection of *English Words*, Ed. 2. p. 174.

† Ibid. p. 200.

V. *The Difference in Time of the Meridians of diverse Places computed from Observations of the Eclipses of Jupiter's Satellites, by the Reverend Mr. Derham Canon of Windsor, and F. R. S.*

SIR *Thomas Derham*, at *Florence*, having lately favoured me with his Transcript of *Monfignor Bianchini's* Observations of the Eclipses of *Jupiter's Satellites*, from the Year 1721, I have laid them down so as to be seen at an easy View, for the Service of the R. S. *Monfieur Bianchini* saith, they were made with a Telescope of *Campani's* grinding of 23 ; *Roman Palms*: That Father *Jo. Bapt. Carboni* at *Lisbon* made use of such another of the same Make, Length, and Goodness; and therefore thinks the Times assigned by them, to be exact; that he drew *Meridian-Lines* at *Assisi* in *Ombria* & *Urbino*; at *St. Quirico* in *Tuscany* and *Florence*: And that *Monfignor Eustach. Manfredi* at the Observatory of *Bologna*, and he observed the Immersion of the first *Satellite* on 25 *August* within two Seconds of one another; *Manfredi* with a Glass of 8 *Bononia* Feet, and he with one of 11; both made by *Campani*. With his own, *Bianchini* hath inserted some Observations, made at the same time by Father *Carboni* at *Lisbon*, and Father *Grammatici* at *Ingolstadt*; *Monfieur Maraldi* at *Paris*, and *Monfignor Eustachius Manfredi* at *Bologna*; as also an Immersion observed by *Mr. Molyneux* near *London* (I suppose at *Kew*) with his reflecting Telescope, and two at *Pekin* in *China* by Father *Ignatius Kogler* a *Jesuit*: But I suppose there is a Mistake in the Observation of *November 30, 1724*, that it was an Emerfion, not an Immersion; the Immersions of the first *Satellite* being not to be seen then.

Sir *Thomas* tells me that Signior *Bianchini* promiſeth his Observations of the circumjovial Eclipses from the Year 1700, and that he will ſend the Society in November his new Globe of *Venus*.

As to the *Bologna* Observations, they were put into my Hands by Dr. *Rutty*, Secr. to the R. S; and are ſaid to be made with a Glaſs of *Campani's*, of 11 *Bologna* Feet. And to ſave the Peruſor the Trouble, I have computed the Difference in Time between the Places in *Bianchini's* and *Manfredi's* Catalogues, and ſome Observations that I had of mine own.

<i>Rome and Lisbon.</i>	<i>Rome and Kew.</i>	<i>Ingolſtad and Lisbon.</i>	<i>St. Quirico and Upminiſter.</i>
H. ' "	H. ' "	H. ' "	H. ' "
I 24 46	0 45 47	I 22 53	0 47 50
I 25 34	<i>Rome and Wanſted.</i>	I 23 21	<i>Florence and Lisbon.</i>
I 26 34	0 49 10	<i>Ingolſtad and St. Quirico</i>	I 19 43
I 29 0	<i>Rome and Up- miniſter.</i>	0 1 20	<i>Florence and Bologne.</i>
I 26 44	0 47 28	0 1 40	0 0 31
I 26 54	<i>Rome and Southwick in Northamp- tonſhire.</i>	<i>Ingolſtad and Bologne.</i>	<i>Florence and Upminiſter.</i>
I 28 11	0 47 58	0 1 53	0 42 1
<i>Rome and Paris.</i>	<i>Urbino and Lisbon.</i>	<i>Ingolſtad and Paris.</i>	<i>Upminiſter and Bologne.</i>
0 39 48	I 28 57	0 36 23	0 43 43
0 40 50	<i>Paris and Lis- bon.</i>	0 36 00	<i>Upminiſter and Lisbon.</i>
0 36 16	0 45 46	0 46 10	0 37 42
0 38 56	0 45 44	<i>St. Quirico and Lisbon.</i>	<i>Bologne and Lisbon.</i>
0 40 17	<i>Paris and Bo- logne.</i>	I 22 30	I 21 24
<i>Rome and In- golſtad.</i>	0 34 30	<i>St. Quirico and Paris.</i>	<i>Bologne and Albano.</i>
0 2 51	0 38 32	0 37 40	0 3 43
0 4 1			
<i>Rome and Bo- logne.</i>			
0 3 43			
0 2 16			
0 4 45			
0 4 14			

Observations of the Eclipses of *Jupiter's Satellites* made by Monsignor *Bianchini* at *Rome*, and other Places: With Accounts of such as he received from other Places.

Days of the Month.	Time of Observation.	Satel. Eclip.	Place where observed.	Days of the Month.	Time of Observation.	Satel. Eclip.	Place where observed.
Anno Domini 1721.				Anno Domini 1724.			
	H. ' "				H. ' "		
<i>Apr.</i> 3	15 4 32	Im. 1	At <i>Rome</i> .	<i>Jun.</i> 8	{ 14 3 28 }		<i>Carboni</i> at
<i>Jun.</i> 21	8 46 0	Em. 1	<i>Rome</i> .	15	{ 15 56 27 }		<i>Lisbon.</i> } I. x
Anno Domini 1722.				23	{ 13 42 50 }		<i>Rome.</i> }
<i>Jun.</i> 9	13 20 0	E. 1	<i>Rome.</i>	30	{ 15 34 29 }	I. 1	<i>Rome.</i>
18	9 36 30	E. 1	At <i>Albano</i> .	<i>Avg.</i> 10	{ 14 8 55 }	E. 1	<i>Lisbon.</i>
<i>Jul.</i> 11	9 49 10	E. 1	<i>Rome.</i>	10	10 45 20	E. 1	<i>Rome</i> , but doubtful.
27	8 7 30	E. 1	<i>Rome.</i>	17	12 40 45	E. 1	<i>Rome.</i>
<i>Aug.</i> 19	8.26 20	E. 1	<i>Rome.</i>	26	9 6 45	E. 1	<i>Rome</i>
Anno Domini 1723.				<i>Sep.</i> 11	7 30 53	E. 1	<i>Rome.</i>
<i>Mar.</i> 26	17 14 50	I. 1	<i>Rome.</i>	18	9 28 16	E. 1	<i>Rome.</i>
<i>Apr.</i> 11	15 31 45	I. 1	<i>Rome.</i>	25	{ 11 25 55 }	E. 1	<i>Rome.</i>
<i>May</i> 3	{ 15 48 51 }	I. 1	<i>Rome.</i>	<i>Oct.</i> 11	{ 9 59 21 }	E. 1	<i>Lisbon.</i>
	{ 15 43 05 }	I. 1	At <i>Ingolstadt</i> by F. Grammatici.	14	{ 9 53 8 }	E. 1	<i>Albano.</i>
27	18 56 0	I. 1	<i>Rome.</i>	14	{ 9 31 0 }	E. 3	From the Limb of Ψ into γ Shadow. <i>Albano.</i>
<i>Jun.</i> 5	12 16 30	I. 1	<i>Rome.</i>	27	8 16 0	E. 1	<i>Albano.</i>
12	14 11 39	I. 1	<i>Rome.</i>	<i>Nov.</i> 12	5 33 10	E. 1	<i>Rome.</i>
<i>Jul.</i> 23	{ 9 11 40 }	E. 1	<i>Rome.</i>	19	8 25 5	E. 1	<i>Rome.</i>
	{ 7 46 05 }	E. 1	<i>Lisbon</i> , by Fa. <i>Carboni</i> .	30	6 14 0	I. 1	At <i>Peking</i> in China, by F. Forger the <i>Jejun</i> .
30	11 7 20	E. 1	<i>Rome.</i>	<i>Dec.</i> 5	6 42 25	E. 1	<i>Rome.</i>
<i>Aug.</i> 8	7.32 0	E. 1	At <i>Ocricali</i> in <i>via flaminia</i> .	Anno Domini 1725.			
15	9 35 0	E. 1	At <i>Astisi</i> in <i>Ombria</i> .	<i>Jun.</i> 19	15 17 10	I. 1	<i>Rome.</i>
<i>Sep.</i> 7	{ 9 50 45 }	E. 1	<i>Urbino.</i>	<i>July</i> 5	13 32 20	I. 1	<i>Albano.</i>
	{ 8 21 48 }	E. 1	<i>Lisbon.</i>	7	14 55 30	I. 1	<i>Pekin.</i>
23	8 17 54	E. 1	At <i>Muceria</i> in <i>Ombria</i> .	21	{ 11 45 22 }	I. 1	<i>Rome.</i>
<i>Oct.</i> 16	8 36 10	E. 1	At <i>Albano</i> in the <i>via appia</i> .		{ 10 89 35 }	I. 1	Mr. <i>Molineux</i> near <i>London</i> .
				28	{ 13 39 10 }		<i>Rome.</i>
					{ 12 12 26 }	I. 1	<i>Lisbon.</i>

Day of the Month.	Time of Ob- servation.	Satel. Eclip.	Place where observed.	Day of the Month.	Time of Ob- servation.	Satel. Eclip.	Place where observed.
				Anno Domini 1728			
Nov. 15	{ 9 53 50 } 8 24 50	E. 1	Rome. Lisbon.	Jan. 15	13 13 46	E. 1	Rome.
— 14	6 15 15	E. 1	Rome.	Feb. 16	9 46 56	E. 1	Rome.
Dec. 17	6 20 30	E. 1	Rome.	Mar. 26	8 32 7	E. 1	Rome.
Anno Domini 1726				Observations made at the Observatory of Bologna, by Monsignor Inghis-M. Fris.			
				Anno Domini 1726			
Jul. 17	{ 13 28 46 } 13 24 45 12 1 52	I. 1	Rome. Ingolstadt. Lisbon.	Aug. 16	15 29 0	I. 1	Dubious.
Aug. 2	11 40 0	I. 1	St. Quirico in Tuscany.	— 25	11 54 24	I. 1	Dubious.
— 9	{ 11 41 20 } 13 36 0	I. 1	Ingolstadt. Siena in Tuscany.	Nov. 27	9 35 11	E. 1	Dubious.
— 16	{ 12 13 30 } 15 28 29 14 8 46	I. 1	Lisbon. Florence. Lisbon.	Dec. 4	11 27 45	E. 1	Dubious.
— 16	{ 15 29 0 } 11 54 24 11 54 26	I. 1	Bologne. Bian. } At Man. } Bol.	— 26	5 47 4	I. 3	Dubious.
Aug. 25	{ 11 56 18 } 11 19 55	I. 1	Ingolstadt. Paris.	— 26	7 56 23	—	The third began to emerge.
— 26	{ 10 32 57 } 8 41 0	I. 1	Lisbon. St. Quirico.	— 31	29 59 20	E. 1	Just began.
Sep. 26	{ 8 39 20 } 8 3 20	I. 1	Ingolstadt. Paris.	Anno Domini 1727			
Oct. 1	16 7 45	I. 1	St. Quirico.	Jan. 2	9 45 27	I. 3	Dubious.
Nov. 20	{ 7 46 30 } 6 20 19	E. 1	Rome. Lisbon.	— 5	11 53 38	E. 3	Dubious.
— 27	9 39 25	E. 1	Rome.	— 7	7 51 54	E. 1	Dubious.
Dec. 6	{ 6 0 16 } 5 58 0	E. 1	Rome. Bologne.	— 7	8 54 12	F. 2	Dubious.
— 6	5 24 0	E. 1	Paris.	Feb. 7	{ 5 50 5 } 7 52 54	I. 3	Dubious.
Anno Domini 1727				— 8	8 37 59	E. 2	Air thick.
Mar. 8	6 42 50	E. 1	Rome.	Aug. 21	13 34 39	I. 1	Dubious.
— 15	15 18 27	I. 1	Rome.	Sep. 6	11 55 17	I. 1	Dubious.
Aug. 5	{ 15 0 8 } 14 21 12	I. 2	Rome. Paris.	— 17	{ 10 48 59 } 12 40 31	E. 3	Dubious.
— 6	{ 12 0 0 } 11 55 15	I. 1	Rome. Bologne.	Oct. 13	16 5 45	I. 1	Dubious.
Sep. 6	{ 11 19 43 } 10 41 30	I. 1	Paris. Albano.	— 22	12 29 42	I. 1	Dubious.
Oct. 15	10 41 30	I. 1	Albano.	— 27	8 55 34	E. 3	Dubious.
— 20	6 5 54	I. 1	Albano.	— 30	11 1 9	I. 3	Dubious.
— 22	12 33 23	I. 1	Albano.	Nov. 5	9 5 15	I. 2	Dubious.
				— 30	8 44 13	E. 2	Dubious.
				Anno Domini 1728			
				Jan. 17	8 41 8	F. 3	Dubious.
				Feb. 16	9 43 11	E. 1	Dubious.
				— 29	{ 6 40 45 } 8 50 40	I. 3	Dubious.

VI. *Extract of a Letter to the Publisher from*
Monf. De Lifle, Astronomer Royal at Peters-
burgh, containing his Observations of the Eclipses
of Jupiter's Satellites from July 10th, 1726,
to April 12th, 1728, taken at that Place.

Petersburgh, July $\frac{2}{25}$, 1728.

S I R,

I Send you at present all the Observations of the
Satellites of Jupiter that I have made here the
 two last times of his Appearance; and I don't question
 but there will be Number sufficient to settle the Differ-
 ence of our Meridians, by comparing them with the
 Observations made in *England*. The following were
 made with common Telescopes of 13, 15, 20 $\frac{1}{2}$, and
 22 Foot; and are very good ones —

1726.	D.	H.	'	"	What Eclipse.	Telescope.	
July	10	12	47	0	Im. of the 1st.	15 Foot.	a little doubtful.
Aug.	9	14	51	30	Immer. —	15 and 22	doubtful near 15".
	18	11	15	46	Immer. —	15 —	
		11	15	52	Immer. —	20 $\frac{1}{2}$ —	
Sep.	10	11	32	51	Immer. —	15 —	
		11	32	56	Immer. —	20 $\frac{1}{2}$ —	
	22	16	13	20	Immer. —	15 —	
Oct.	19	12	21	46	Em. —	15 —	
	28	8	47	8	Em. —	15 —	to some "
Dec.	6	7	11	18	Em. —	20 $\frac{1}{2}$ —	somewhat doubtful.
		10	30	31	Em. —	20 $\frac{1}{2}$ —	exact.
		10	30	38	Em. —	15 —	exact.
	29	7	15	36	Em. —	20 $\frac{1}{2}$ —	exact.
		7	15	48	Em. —	15 —	exact.
1727.							
Jan.	2	10	59	46	Immer. —	15 —	Air foggy.
		11	0	17	Immer. —	20 $\frac{1}{2}$ —	

Feb.

D.H.		What Eclipse.		Telescope	
	7 10 9 56	Emmer.	—	2 20	Foot
	10 10 4	Em.	—	15	
Feb.	1 7 17 15	Em.	—	2 20	exact.
Aug.	5 11 52 23	Immer.	—	3 22	to a few "
	7 10 59 27	Immer.	—	1 22	4 was low
	8 13 37 9	Immer.	—	2 22	
	21 14 50 30	Immer.	—	1	
	30 11 19 18	Immer.	—	1	
Sept.	2 10 43 57	Immer.	—		
	6 13 11 24	Immer.	—		doubtful
	9 13 21 35	Immer.	—		
	10 9 34 30	Emmer.	—	1 22	
	15 9 36 32	Immer.	—		
Oct.	31 10 8 48	Immer.	—	1 5	doubtful
Dec.	2 8 46 30	Em.	—	1	
	12 14 6 0	Em.	—	2 2	
1728.					
Jan.	8 12 14 44	Em.	—	1 5	to some "
	12 33 34	Em.	—	1 3	somewhat doubtful
	10 5 58 7	Em.	—		to some "
	7 0 12	Em.	—		the wind incommodes
	17 7 56 31	Im.	—		exact.
	8 53 4	Em.	—	1 22	
	9 55 14	Em.	—	5 --	
Feb.	16 10 59 26	Em.	—	1 22	to some "
	18 5 28 20	Em.	—	1 15	the day not closed.
	27 6 40 5	Em.	—	2 22	
	29 8 0 29	Immer.	—	3 22	the Satellite appear- ed and disappear- ed at different Times.
Mar.	10 11 18 19	Em.	—	1 13 and 15	
Apr.	12 8 16 12	Immer.	—	3 15	
	10 30 40	Em.	—	3 15	4 was low.

I am, &c.

DE LISLE.

F I N I S.

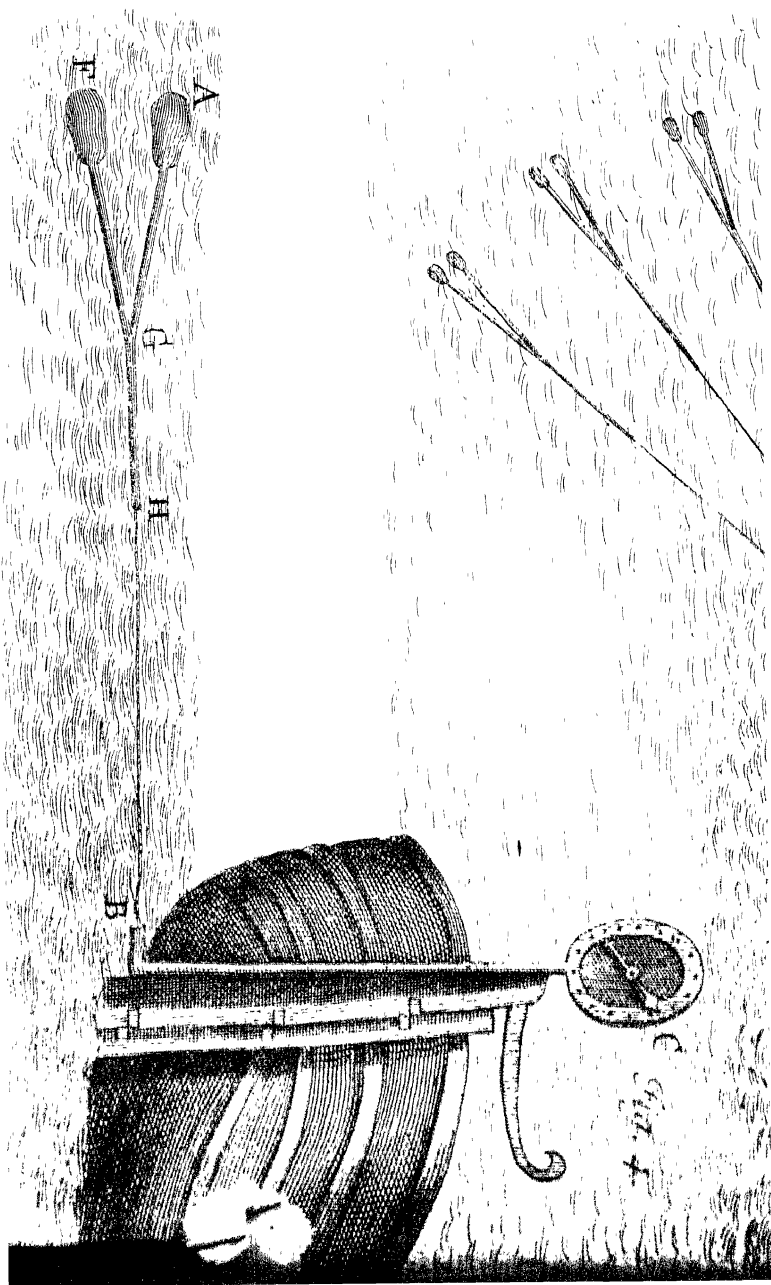


Fig. 1.

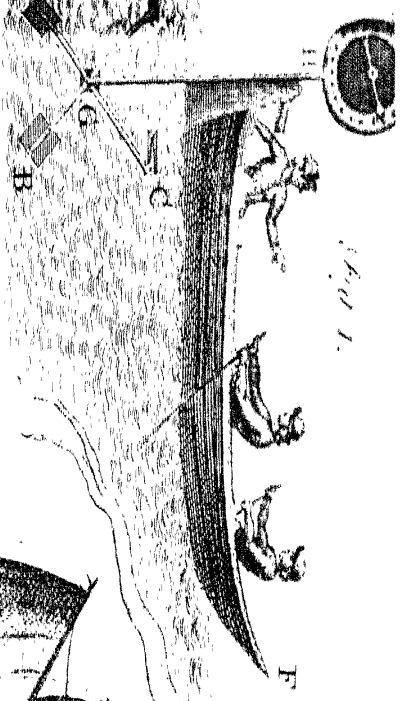
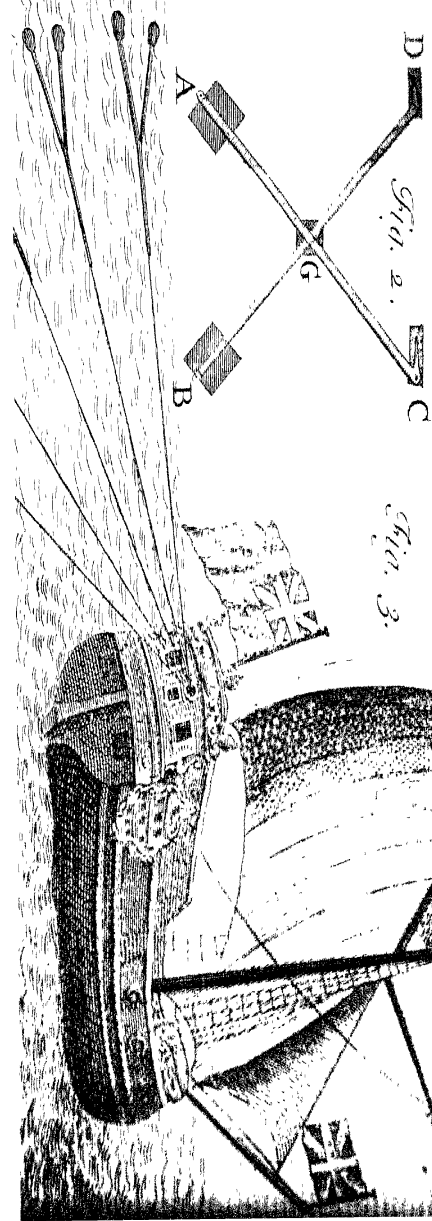


Fig. 3.



When the vessel is in the water

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *March* and *April*, 1729.

The CONTENTS.

- I. QUERIES, concerning the Cause of Cohesion of the Parts of Matter, proposed in a Letter to Dr. Desaguliers, F. R. S. By Fr. Triewald, Director of Mechanicks in the Kingdom of Sweden.
- II. A Letter to Dr. Rutty, R. S. Secr. giving a farther Account of the Nature and Virtues of the Holt-Waters, from the Reverend Mr. J. Lewis, Vicar of the Place.
- III. A farther Account of a new Machine, called the Marine Surveyor, designed for the Mensuration of the Way of a Ship at Sea, more correctly

The CONTENTS.

rectly than by the Log, at present in Use, or any other Method hitherto invented for that Purpose. By Mr. Henry de Saumarez of the Island of Guernsey, Part of his Majesty's antient Dutchy of Normandy.

- IV. *A second Letter from Mr. Colin M^r Laurin, Professor of Mathematicks in the University of Edinburgh and F. R. S. to Martin Folkes, Esq; concerning the Roots of Equations, with the Demonstration of other Rules in Algebra; being the Continuation of the Letter published in the Philosophical Transactions, N^o 394.*

L O N D O N :

Printed for W. INNYS, at the *West-End* of St.
Paul's Church-Yard.

I. *QUERIES, concerning the Cause of Cohesion of the Parts of Matter, proposed in a Letter to Dr. Desaguliers, F. R. S. By Fr. Triewald, Director of Mechanicks in the Kingdom of Sweden.*

Stockholm, Novem. 20. 1728.

Reverend S I R,

HAVING lately received the *Transactions* of the *Royal Society*, published since I left *England*, in order to settle in my native Country, I find you have been pleased, in *Numb. 389*, to take Notice of my Experiments made concerning the Cohesion of two Balls of Lead; and as I don't know any Body has assigned the true Cause of this Phenomenon, I beg you'll be pleased to propose the following *Queries* to that illustrious Society of which you are a worthy Member.

Query I. Does not this strong Cohesion of two Balls of Lead prove the Doctrine of Attraction, worthy its great Author, your late President Sir *Isaac Newton*; and that there is a universal Attraction between the Parts of Matter in Nature, though some at such small Distances as to escape our Observations, since we cannot make their Parts touch one another close enough, so as to come within their Sphere of Activity? Which I presume to be the Reason, why I never have been able to make Balls of any other Metals to cohere: Nor do I believe that the Parts of any other Metal can come to such a close Contact, except by Fusion, as the Particles of Lead may, by

G

being

being so many Degrees softer than those of any other Metal.

Query II. I have often found the touching Surfaces of such Leaden Balls, as near as I could measure, much alike; yet the Force of Cohesion very different: Nay, I have found the touching Surfaces very small, yet sometimes 114 to 126 lb Weight has not been sufficient to separate them; when at other Times a far less Weight (though the Measure of touching Surfaces far exceeded those mentioned) was more than sufficient to cause their Separation. Does it not prove that the Cohesion is strongest according to the closeness of the Contact, but not as the touching Surfaces? For which Reason I always have found the Cohesion strongest, when I gave a little twist in joining them; since by this Means the Particles must come closer together, than by squeezing the Balls barely on one another, though it was done with a far greater Force than I could apply with my bare Hands. And since the Force, Twist, and touching Surfaces can never be alike and mensurable when joined by Hand, I think it will be very difficult, if not impossible to ascertain the Forces of this Cohesion, which is incredible, and far exceeds Magnetical Attractions.

That the Pressure of the Atmosphere contributes little, and next to nothing in this Cohesion, I have fully proved and experienced last Winter, before a great and noble Assembly at my Lectures held in this Place: The Cohesion of two Leaden Balls, which 126 lb could not separate, prov'd as strong in *Vacuo*, as in the open Air.

Query III. Does not this Experiment fairly account for the Cohesion of the Parts of Matter; and that this firm Cohesion cannot be derived from any Glue or Cement, any imaginary Hooks and Funiculus, nor *de gravitate Aetheris*: but that the Particles of all solid and fluid Bodies do attract one another by a certain Force (whatever be the Cause of the same) which acts most intensely the nearer they touch one another.

I am confirmed in this Opinion by an Experiment I made this Summer at *Dannemora*, one of the most considerable Iron Mines, and where I have erected the first and largest Fire-Engine for drawing Water and Oar in this Kingdom; the Cylinder being two Lines more than thirty-six Inches in Diameter.

Our *Dablkarians* have, 'Time out of Mind, practised the said Experiment, when they have had Occasion to remove any unweildy Stones of the hardest Rocks, and so big as not to be moved entire by any Strength they could apply. They practise the following Means, not only to cleave and split them in as many Parts and Pieces as they please, but they obtain Stones with one or more smooth Sides, fit for Use in Buildings. Their Method is thus.

They take Tallow, Grease, Train Oil, or any other fat Substances, and draw Lines on such large Stones, according as they would have them split, and think proper; then they lay either Char-Coal or Wood at Top, and round the Sides of the Stone, so that it is all over covered, and then kindle the Fuel; which when burned out, they find the Stone divided according to the Lines they have drawn on the same,

with some of the before-mentioned fat Substances, which seldom or never fails.

May one not account for this odd *Phænomenon* thus? That as the Action of Heat and Fire expands the Parts of all hard and solid Bodies and Metals themselves, so when the Action of the Fire about the Stone has made the Particles of the same recede farther from one another, than when in their natural State, the oily Substances insinuate themselves more and more between the Particles of the Stone; by which Means, when the Stone cools again, and shrinks, they seem to prevent these Particles from coming as close, and within their Sphere of Activity, as the remainder Particles may, where no such foreign Matter has been applied; by which Means they also cannot attract one another so strongly as the rest, and must therefore remain separated.

Fat and oily Substances seem to be most fit for this same Purpose, since they are endued with a repelling Force.

I can't but admire, that notwithstanding so many *Phænomena* in Nature prove a Tendency and a strong mutual Attraction of the Parts of Matter, whatever be the Cause, yet most learned Men, of several Nations, would rather charge such manifest Qualities and Operations of Nature with the Nick-Name of occult Qualities, than give the Honour to the *great Discoverer (who is no more)* of those manifest Qualities and Principles of Motion. However, I am confident, that as Nature is very uniform and agreeable to herself, she'll evince the Truth of her Operations.

If I find you pardon this Liberty I have taken by this, it will encourage me to transmit several Experiments and Observations I have lately made, remaining with the utmost Sincerity,

Most Reverend S I R,

Your most obedient humble Servant,

F. Triewald,

*Director of Mechanicks in the
Kingdom of Sweden.*

II. *A Letter to Dr. Rutty, R. S. Secr. giving a farther Account of the Nature and Virtues of the Holt-Waters, from the Reverend Mr. J. Lewis, Vicar of the Place.*

S I R,

IN a Letter I received lately from Mr. *Brome*, he gave me an Account that he had communicated to you a Paper of mine, relating to the Mineral Waters at *Holt*; and that you had sent it to the Press among the *Philosophical Memoirs* of the *Royal Society*; which I was pleased to hear, because I hoped it might be a Means to raise the Esteem of the Waters, and recommend them to the good Opinion of the learned World. He likewise informed me, that you was willing to enquire into some further Particulars relating to those Waters.

This Intimation of yours to Mr. *Brome* has drawn upon you the Trouble of this Paper; being willing
to

to make known, as far as lies in me, the excellent Virtues of these Waters, of which I have been an Eye-witness for several Years in many extraordinary Cures.

Experience has proved them of admirable Efficacy in Scorbutick and Scrophulous Cases: wherein they have done such Wonders, that a short Account which was published of their Cures in that Kind, about five Years ago, was looked upon by some, rather as a romantick Tale, than a true Narrative of real Facts.

They are of an attenuating, astringent and drying Nature: And by these Qualities, I imagine, they perform their Cures. The first is the known Property of all Water, to dilute the Blood, and thin the Juices, and thereby to fit them to pass the fine Strainers, and be carried out of the Body by their proper Drains. In the Second consists the great Excellence of *Holt-Water*, which, by its notable Astringency, braces the Solids, stimulates the Fibres, and quickens their contractile Power, and thereby enables them to shake off, protrude and squeeze out such Feculencies, as may adhere to, clog and stuff them up. And this Quality, it is probable, they derive from the Allom and Iron that are supposed to impregnate them. The Ingredients, which give them their drying, absorbing and healing Quality, are the Sulphur and Ochre; by which they imbibe the peccant Humours, and sheath the sharp Salts, that lance and tear the finer Glands, and cause Blotches, and Ulcerations. As they attenuate and astringe, they are a noble Diuretick, removing Obstructions from the Kidneys, and causing the Renal Glands to make their due Secretions, and at the same Time

Time dissolving the grosser Salts, and fitting them to be carried off through the Urinary Passages.

These Waters have been found of excellent Avail in many other Illnesses, besides the Scurvy and Evil: But I forbear mentioning any other Cases, lest I trespass against good Manners, by making my first Visit too long. I am with all due Respect,

S I R,

Your very humble and obedient Servant,

Holt, Dec. 16.
1728.

John Lewis.

III. *A further Account of a new Machine, called the Marine Surveyor, designed for the Mensuration of the Way of a Ship at Sea, more correctly than by the Log, at present in Use, or any other Method hitherto invented for that Purpose. By Mr. Henry de Saumarez, of the Island of Guernsey, Part of his Majesty's antient Dutchy of Normandy.*

HAVING given an Account of my Projection for ascertaining the Run of a Ship at Sea, which has appeared in the *Philosophical Transactions* of the *Royal Society*, Vol. xxxiii, for the Months of *November* and *December* 1725; as also in those for the Months of *March* and *April* 1726;
2 and

and having been since frequently employed in making Experiments thereof, and Improvements thereon, I take Leave to add what follows as a Supplement to those Discourses on this Invention, which I am humbly of Opinion may, in Time, prove of great Use in those extensive Branches of our foreign Commerce, wherein so many of his Majesty's Subjects are concerned.

At my publickly setting out on this Invention, I had his late Majesty's Leave several Times to have a Boat on the Canal in St. *James's Park*, where the Shallowness of the Water was such, that it would not admit of my using the Iron Fork, the Weight of which may be about four Pounds, and which I have described in the *Transactions* afore-mentioned; and therefore I was obliged to fall on some Expedient to answer my Purpose in such a Depth of Water. Various were my Designs to this End; however at length I fixed such a Machine to my Boat, as had an equal Number of Revolutions in a measured Distance of 2000 Feet, even though the Boat went swift or slow; of which the Reverend Dr. *Desaguliers*, and some other Mathematicians, at Times, were Witnesses. As I did not describe this Instrument in the former Account of my Machine, where it seems to lie blended with that of the Fork, I shall give a Description of it here in the following Figures, *viz.*

In the First of these Figures, F represents my Boat on the Canal in St. *James's Park*, through the Rudder of which a small Spindle passes (in an Iron Pipe) of which H G is the Length. To the Point G are fastened the four Iron Fins, or Flyers, A, B, C and D, in the Form of a Square, the Bars D B and A C, to which they are fixed, lying in an horizontal Position. These Flyers are so contrived as to have full Play in any Motion of the Boat. To the Point H, which is the upper Part of the Pipe and Spindle, is fixed the Dial E: Now the Boat being put into Motion, the Flyers move accordingly, which proportionally affecting the Spindle, the Motion is thereby communicated to the Dial, which may be fitted to strike the Miles or Leagues that the Vessel runs.

But to describe the first Movement of this Machine more exactly, *Fig. 2.* represents it unfixed. The Cross, or Bars D B and A C, as I said before, lie flat, or in an horizontal Position; the Arbor or Spindle, which is perpendicular thereto, screws into the Point G, and passes through an Iron Pipe to the Dial, in manner aforesaid. The Flyers A, B, C and D being fitted to move in any Motion of the Boat, the Bars are accordingly affected. This Instrument is so contrived, that two of the Flyers on one Side shall always resist the Water in the Motion of the Vessel, whilst the other Two give Way in their Turning. The resisting Flyers in this Figure are A and B, and D and C will be the same when they come into their Position; for they resist and give Way alternately so long as the Motion continues, which is always circular; and so truly does it revolve, that

H

be

be the Motion swift or slow, in any measured Distance, the Number of Revolutions will be equal.

This is the Machine which I first tried on the Canal in St. *James's Park*, and with this it was, that I made my Observations on the Tides in the River *Thames*, as they appear in the *Philosophical Transactions* for the Months of *March* and *April* 1726 ; which I chose the rather to do, in regard I found it to answer very well in all my Experiments. And I am yet of Opinion, that it would be an useful Instrument to determine the Strength of the Tides on our Sea Coast, which if marked in our Charts, might prove advantageous to our Commerce. But considering, that though this Projection might be serviceable in Barges, Pleasure-Boats, or other Vessels, in fair and moderate Gales of Wind, yet it might prove useless in boisterous and stormy Weather, and in long Voyages, when it might be choaked with Weeds ; I therefore fixed to my other Invention the Fork, which is contrived in such a Manner, that I will even yet be so bold as to affirm, it shall determine the Ship's Way in a Storm, or when she is scudding before the Wind, when the *Log* is incapable of it. As the Canal would not allow me to try, with any Certainty, my Iron Forks there, I was obliged to have some made of lighter Materials, which seemed to answer somewhat near the Truth, and made me so sanguine as to believe, that they would have an equal Number of Revolutions in the same Distance, even though the Motion of the Boat was swift or slow between Mark and Mark. I must here do my worthy Friend Dr. *Desaguliers* (who frequently honoured me with his Company in the Experiments of the
aforesaid

aforesaid Invention) the Justice to own, that he dif-
fented from me in this Particular, in regard he faid the
Works muft have different Pofitions, according to the
Velocity of the Veffel to which they were fixed, and
confequently could not have an equal Number of Re-
volutions in fwift and flow Motion.

Whilst I was confidering where to carry on my
Experiments to prove the Verity of my Inftrument,
and to answer this Objection, I had the Honour
to be introduced to the late ingenious *Samuel Moly-
neux*, Efq; whose Memory will always remain dear
to me. As he was ever ready to encourage all lau-
dable Defigns, and particularly fuch as were calcu-
lated for Publick Good, he foon became my Patron:
And as he was then one of the Lords Commiffioners
of the Admiralty, and my Machine fell within his
Province, he exprefs'd a Defire to fee an Experiment
of it on the River *Thames*: Accordingly I fhew'd to
him, and feveral of the principal Officers and Com-
miffioners of his Majesty's Navy, the Nature and
Ufe of it between *London* and *Woolwich*, when he
feemed to be of the fame Opinion with Dr. *Desa-
gulier*s, viz. Whether in a certain Difftance, and in
different Motions of the Veffel, the Inftrument could
revolve equally. Hereupon he advifed me to take a
Trip over to *Holland*, and to try my Machine with
the Log, in my Passage; as alfo thoroughly to examine
the Truth of his Objection on the long Canals in
that Country, where there was little or no Tide or
Current.

Accordingly I had Orders to embark on Board the
William and *Mary* Yacht, which was ordered to
carry over the Lady of Count *Welderen*, one of the

then *Dutch* Ambassadors at our Court, to compliment his Majesty on his Accession to the Throne. My Machine being fixed at the Stern of this Vessel, we kept her Run both by it and the *Log*. On the nicest Calculation, in our Passage over, the Difference between us was 2 Miles and 2640 Feet: At this I was in no wise surpris'd; for as I knew the *Log* to be very erroneous, and I undertook to correct the Errors of it by my Instrument (in the Truth of which I might then be too forward, as too many are on such Occasions) I was assured we could not agree; and therefore I charged the Difference accordingly.

Among the considerable Company on board the Yacht, we had a curious Gentleman, Captain *Lynslager*, Commander of one of the *Dutch* Men of War, who seem'd not a little pleas'd with my Contrivance; and no sooner did he land in *Holland*, but he spoke of it to some Gentlemen of the highest Rank there, whose Curiosity induced them to desire to see an Experiment of this Invention: Accordingly I was sent for to the *Hague*, and on the Canal there, before Baron *Hop*, Baron *Wassenaar*, Admiral *Somelsdyk*, Mr. *s'Gravesand* (Professor of the Mathematics in the University of *Leyden*) Captain *Lynslager*, &c. we run a certain Distance in swift and slow Motion, in order to see if the Instrument would have an equal Number of Revolutions therein. In running up, it revolv'd 2300 Times, and in coming down 2060. Here then was enough to convince me, that Dr. *Desaguliers*, and Mr. *Molyneux*, had judg'd truly of the Fork, and more especially since the learned Mr. *s'Gravesand* joined in Opinion with

3

them;

them; who notwithstanding encouraged me, by telling me my Labour was not in vain, for that the Instrument might still be of good Service, by making Tables to rectify the different Revolutions.

An Opinion strongly indulged is rarely parted with; the Truth of which I find in my self; for although Dr. *Desaguliers*, Mr. *Molyneux*, and Mr. *s'Gravesand* did jointly agree as to this Invention, yet still did I entertain some slender Thoughts, that it must answer the Purpose, in the Manner I had proposed. For when I considered, that I had two Fathom of Rope out on the *Dutch Canal*, which was but 5 or 6 Feet deep, and that the Fork of my Machine weighed about three Pounds, or three and a half, and was two Feet and a half in Length, I thought it not unreasonable to suppose, that its Weight, in the slowest Motion of the Vessel, might occasion it to strike Ground, and consequently impede its Motion, and lessen the Number of Revolutions as above. Of this I had been fully satisfied whilst in *Holland*; but fearing to lose my Passage in the Yacht, on Board of which I had embarked by Order of the Lords Commissioners of the Admiralty, I was obliged to hasten over.

Not long after I came to *England* died my worthy Patron Mr. *Molyneux*, in whom all Men of Learning and Ingenuity lost a Friend; and as there was now but little Hope of my going over to *Holland* in the Manner I had done before, I was notwithstanding resolved to take that Journey at my own Expence; and accordingly did so, where I no sooner began my Experiments, but I was convinced of the Truth of the Objections of the three
learned

learned Gentlemen afore-mentioned, which is plainly made appear from the following Figure, wherein the Position of the Fork, in five different Motions of the Vessel, is represented. See Fig. 3.

This needs no Explanation, for it plainly appears, that the Pallets will be more or less affected by the Resistance of the Water, according to the Position they are in; and therefore the Revolutions in a swift or slow Motion, in the same Distance, cannot be equal.

Being now fully persuaded, that the Fork would not revolve equally in the same Distance, and in different Motions of the Vessel, I now begin to repair this Defect by calculating some Tables, which render it still a very useful Instrument. On what Foundation I formed these Tables, there will be no need for me to mention, since I shall go on to shew what further Improvements I have made of this Instrument, and that it is now every Way useful without them. And this, I think, I cannot better do, than by entering here the Extract of a Letter to Dr. *Desaguliers* from a learned Mathematician in *Holland*, whose Company I was honoured with several Times, whilst I was making my Experiments on that Side, viz.

“ Mr. *De Saumarez* having desired me to acquaint
 “ you of the Success of the Experiments, which I
 “ have seen him make of this Machine, for the measu-
 “ ring the Way of a Ship in the Sea, it is with Pleasure
 “ I undertake it, since I am fully persuaded you
 “ will not be wanting to contribute all in your Power
 “ to promote an Invention so useful and advantage-
 “ ous as this is.

“ The

“ The first Experiment that I attended was with an
 “ Iron Fork, such as the Gentleman himself hath de-
 “ scribed in the *Philosophical Transactions* of the
 “ *Royal Society*; when the Number of Revolu-
 “ tions were more in the swift than in the slow Mo-
 “ tion of the Boat, whereon we tried this Instru-
 “ ment. This I take to be owing to the different
 “ Inclinations of the Machine; which were more
 “ Horizontal, according as the Motion of the Boat
 “ was more swift; from whence we concluded, that
 “ it would be necessary to help this by some Ta-
 “ bles calculated for the Purpose: Since which, Mr.
 “ *De Saumarez* hath accordingly formed such Tables;
 “ but as I was not present at the Experiments where-
 “ on they are founded, I leave you to the Gentle-
 “ man himself to give you an Account thereof.

“ I have also made another Experiment with Mr.
 “ *De Saumarez*, upon a new Correction of his Ma-
 “ chine, which he will better explain to you, when
 “ you see him, than I can describe. Here he has
 “ contrived the first Movement of his Machine to lie
 “ Horizontal under the Water; and such was our
 “ Success in this Experiment, that I make no more
 “ doubt of the Usefulness of this Invention, which
 “ I look upon as very advantageous to Navigation;
 “ since the Number of Revolutions here scarcely
 “ differed 4 in 332 in the different Velocity or Mo-
 “ tion of the Boat: But this I must observe, that
 “ the Number of Revolutions here were greater
 “ when we moved most slow. For my Part, I do
 “ not question, but that by a small Correction, the
 “ Number of Revolutions may be always rendered
 “ proportional to the Distance; yet let us make no
 “ Hypo-

“ Hypotheses ; for Experiments of this Machine,
 “ wherein may be had some Millions of its Revo-
 “ lutions, will perfectly shew the Use that may be
 “ made thereof. In the Interim I believe, that Mr. De
 “ Saumarez’s Invention may be, nay, ought to be,
 “ especially with this last Improvement, *infinitely*
 “ *preferred to all other Methods for ascertaining*
 “ *the Way of a Ship in the Sea, &c.*

Here then you have the Opinion of a learned Gentleman of my Improvement on this Invention, whose Eminence among the *Literati* is such, that this alone might give a Sanction thereto. It is here observed, that the Difference in the Revolutions of my Machine, on this new Method, was scarcely 4 in 332 : Who then can say this Difference was not owing to the different Sheers in our Boat on the Canal ? But I shall not go about to determine this, it remains for me now only to shew the Improvement which I made of the *Marine Surveyor* whilst in *Holland*, which is hinted at in the Letter above, and which is now brought to such Perfection, that I persuade my self no very material Objections can be brought against it. The following Figure shews this Improvement, wherein the Objections of the different Inclinations of the Fork are now entirely removed. See Fig. 4.

A F G H is the Fork, in the same Form as the Iron Fork described in the *Philosophical Transactions*, Vol. xxxiii, for the Months of *November* and *December* 1725, which differs from the other only in the Materials of which it is framed ; this being contrived of such as to make it equiponderous with the Water, and to lie in an Horizontal Position,

sition, even though the Ship or Vessel to which it is fastened be at Anchor, or under Sail. H B is a Rope, ~~of~~ a convenient Length, fixed to a Screw or Worm at the Point B, which goes about 6 Inches into an Iron Pipe, of which B I is the Length: Through this Pipe an Iron Spindle passes into the aforesaid Screw or Worm to which the Dial C is fixed; as soon then as the Vessel moves, the Fork plays in an Horizontal Position, which moving the Spindle within the Iron Pipe, the Motion is thereby communicated to the Dial, which is fitted to strike to the Miles or Leagues the Vessel runs; and let the Vessel move swift or slow, the Pallets A and F are equally affected, and consequently must measure the Distance sailed to a greater Exactness than the Iron Fork is capable of in the Manner I have described it in the *Philosophical Transactions* aforesaid. For want of better Conveniencies when in *Holland*, I had this Iron Pipe fixed to a thin Board, which I fastened to the Rudder of the Vessel D E; but as I am now falling on a properer Method to fix this Iron Pipe, &c. which I could not well do in *Holland*, since the cold Weather was so far set in, that it would not allow me to make more Experiments than I did on that Side, I hope soon to make it appear, that the Revolutions are exactly equal in this new Improvement of the Fork.

Here then do I offer what I humbly conceive cannot fail being of Service to the Community of which I am a Member, as well as to all the Maritime Powers. 'Tis the Fruit of several Years Study; for my Thoughts were first employed on it, when the Nation felt so great a Loss as it did in the unhappy

Fate of Sir *Cloudestly Shovel*, &c. since which Time (from the Numbers of Workmen I have employed, the various Alterations I have made, and the ~~great~~ Variety of Experiments carried on at my own sole Cost and Charges) I have been at no small Expence; infomuch that my Estate has felt the Weight thereof. However, it is some Satisfaction to me, that I have brought it to the Pitch it is now at, where I cou'd wish to see the Publick take it up, and have it tried by competent Judges against the *Log*; the Errors of which I have amply set forth in a former Discourse. This, methinks, is what I might reasonably hope for, since, as I set out with honest Views, in a praise-worthy Undertaking, I ought (to use the Words of a considerable Author on this Head) to meet with Assistance in the Beginning, with Encouragement if I succeed, and even with Pity, if not Praise, although I should fail.

I am well aware, *that he who decries an old Custom, seldom meets with Success, even though what he advances against it may be very reasonable.* This seems to be the Case between the *Marine Surveyor* and the *Log*; for the latter having been long in Use amongst the Seamen, it may be with Difficulty the former will be received; which probably I may not live to see, since, as I am now bending beneath the Weight of Age and many Infirmities, I cannot be far off bidding Adieu to the Things of this World; and when I shall make my *Exit* from it, God grant some happy Genius may raise a good Structure on the Ground-work which I have here marked out: And I am the more earnest in this Wish, because I am firmly of Opinion,
that

that what is here advanced, if rightly conducted, cannot fail of proving highly advantageous to Trade and Navigation.

January 23d,
1728-9.

Henry de Saumarez,

P O S T S C R I P T.

In a former Discourse on this Invention, and which appears in the xxxiii^d Volume of the *Philosophical Transactions*, I hinted that I was upon making a further Improvement in Navigation, whereby I propos'd to make a Ship work far better to Windward, than it is possible for the most Weatherly one to do at present; as also to make them tack and ware in much less Room than is generally done on such Occasions. The Advantages arising from such a Projection, if it proves practicable, must be considerable; for

1. The Ship which is in Danger of a Lee-Shore will hereby be enabled to weather the Point she may want, and not be forced, in stormy Weather, to anchor in the very Breach of the Shore, and even in the Jaws of Destruction. Of this we have had too many melancholly Instances, where several Lives and Fortunes have been lost; Disasters of which kind, it is humbly conceived, may, in a great Measure, be prevented by this Invention.

2. Hence we need not fear to get the Weather-gage of an Enemy; for by plying to Windward much faster than he can, and by tacking and waring in much less Compass, I can either leave him, or continue to engage him, as shall appear most convenient: At least I can so spend the Day, as to be able to secure my self under the Covert of the Night; or if

I chance to be near the Land, I may hereby be enabled to gain a safe Harbour.

3. By this Invention the wild Steerage which is too frequently made in some Ships, will be prevented, which all Mariners must allow to be of Service, especially in chasing, or being chased by an Enemy; as well as in their keeping the Reckoning of the Ship's Way, &c.

I might here touch on other Advantages arising from this Project, which I omit at present, since as I am about preparing some small Models to shew the Nature of this Contrivance, they will fully appear therefrom: And if what I offer should not be so practicable in large Ships, as it were to be wished, I yet hope some happy Genius will, in Time, so far improve on what I shall hint, as to make the same serviceable to my Country.

When I consider, that to Navigation *Great Britain* owes its Riches and Strength, it certainly ought to have the Preference to all other Arts and Sciences; and therefore any Improvement therein surely cannot fail of meeting with Regard; more especially where such desirable Ends are proposed, as a Method to prevent Ships being wreck'd on Lee-Shores, as also a Means to facilitate the Escape of them, when too powerfully attacked by an Enemy; or leading them to Victory, where they have any Prospect of it, &c. As hereby Honour may accrue to the Nation, and the Lives and Fortunes of several People may be saved, I only desire publick Experiments may be made of these my Machines, on the Proof of which I am willing to stand or fall.

H. D. S.
IV. A

IV *A second Letter from Mr. Colin M^c Laurin, Professor of Mathematicks in the University of Edinburgh and F. R. S. to Martin Folkes, Esq; concerning the Roots of Equations, with the Demonstration of other Rules in Algebra; being the Continuation of the Letter published in the Philosophical Transactions, N^o 394.*

Edinburgh, April 19th, 1729.

S I R,

IN the Year 1725, I wrote to you that I had a Method of demonstrating Sir *Isaac Newton's* Rule concerning the impossible Roots of Equations, deduced from this obvious Principle, that the Squares of the Differences of real Quantities must always be positive; and some time after, I sent you the first Principles of that Method, which were published in the *Philosophical Transactions* for the Month of May, 1726. The Design I have for some Time had of publishing a Treatise of Algebra, where I proposed to treat this and several other Subjects in a new Manner, made me think it unnecessary to send you the remaining Part of that Paper. But some Reasons have now determined me to send you with the Continuation of my former Method, a short Account of two other Methods in which I have treated the same Subject, and some Observations on Equations that I take to be new, and which will, perhaps, be more acceptable to you than what relates to the imaginary Roots themselves. Besides Sir *Isaac Newton's* Rule, there arises from the following general

ral Propositions, a great Variety of new Rules, different from his, and from any other hitherto published, for discovering when an Equation has imaginary Roots. I shall particularly explain one that is more useful for that Purpose, than any that have been hitherto published.

Suppose there is an Equation of (n) Dimensions of this Form,

$$x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} + Dx^{n-4} \\ - Ex^{n-5} + Fx^{n-6} - Gx^{n-7} + Hx^{n-8} - \\ Ix^{n-9} + Kx^{n-10} \&c. = 0.$$

And that the Roots of this Equation are, $a, b, c, d, e, f, g, h, i, k, l, \&c.$ then shall $A = a + b + c + d + e + f \&c.$ and therefore I call $a, b, c, d, e, f, \&c.$ *Parts* or *Terms* of the Coefficient A. For the same Reason I call $ab, ac, ad, ae, bc, bd, cd, \&c.$ *Parts* or *Terms* of the Coefficient B; $abc, abd, abe, acd, bcd, \&c.$ *Parts* or *Terms* of C; $abcd, abce, abcf, \&c.$ *Parts* or *Terms* of the Coefficient D, and so on. By the *Dimensions* of any Coefficient; I mean the Number of Roots or Factors that are multiplied into each other in its Parts, which is always equal to the Number of Terms in the Equation that preceed that Coefficient. Thus A is a Coefficient of one Dimension, B of two, C of three, and so of the rest. I call a Part or Term of a Coefficient C *similar* to a Part or Term of any Coefficient G, when the Part of G involves all the Factors of the Part of C: Thus $abc, abcdefg$ are similar Parts of C and G; after the same manner $abcd, abcdef$ are similar Parts of D and F, the Part of F involving all the Factors of the Part of D. Those I call *dissimilar* Parts that involve no common Root or Factor: Thus abc , and $defgh$ are dissimilar Parts of the Coefficients C and F. The Sum of all the

the Products that can be made by multiplying the Parts of any Coefficient C by all the similar Parts of G, I express by $C'G'$ placing a small Line over each Coefficient: After the same manner $D'F'$ expresses the Sum of all the Products that can be made by multiplying the similar Parts of D and F by each other; and $C' \times C'$ expresses the Sum of the Squares of the Parts of the Coefficient C, but $C' \times C$, expresses the Sum of the Products that can be made by multiplying any two Parts of C by one another. These Expressions being understood, and the five Propositions in *Phil Trans.* N^o 394, being premised, next follows

P R O P. VI.

If the Difference of the Dimensions of any two Coefficients C and G be called (m) then shall the Product of these Coefficients multiplied by one ano-

$$\text{ther be equal to } C'G' + \overline{m+2} \times B'H' + \frac{m+3}{1} \times \frac{m+4}{2} A'I' + \frac{m+4}{1} \times \frac{m+5}{2} \times \frac{m+6}{3} \times I \times K.$$

Where B and H are the Coefficients adjacent to the Coefficients C and G, A and I the Coefficients adjacent to B and H, I and K the Coefficients adjacent to B and H.

It is known that $C = abc + abd + abe + abf + abg, \&c.$ and $G = abcdefg + abcdefh + abcdefi + bcdefgh, \&c.$ and it is manifest,

1. That in the Product CG each Term of $C'G'$ will arise once as $a^2b^2c^2defg$. But

2. Any Term of $B'H'$ as $a^2b^2cdefgh$ may be the Product of abc , and $abdefgh$, or of abd and $abcdefgh$, or of abe and $abcdfgh$, or of abf and $abcdegh$,

$a b c d e g h$, or of $a b g$ and $a b c d e f h$, or lastly of $a b h$ and $a b c d e f g$; so that it may be the Product of any Term of C that involves with $a b$ one of the Roots, c, d, e, f, g, h , multiplied by that Term of G, which involves $a b$ and the other five; that is, it may arise in the Product CG as often as there are Roots in $a^2 b^2 c d e f g h$ besides a and b , or in general, as often as there are Units in the Difference of the Dimensions of B and H, that is, $m + 2$ times; because m expresses the Difference of the Dimensions of C and G, and consequently in expressing the Value of CG the Coefficient of the second Term B'H' must be $m + 2$.

3. Any Term of AI, as $a^2 b c d e f g h i$, may be the Product of any Part of C that involves the Root a with any two of the rest b, c, d, e, f, g, h, i (the Number of which is the Difference of the Dimensions of A and I, which is in general equal to $m + 4$) multiplied by the Part of G that involves a and the other fix; and therefore $a^2 b c d e f g h i$ or any other Term of A'I' must arise as often as different Products of two Quantities can be taken from Quantities whose Number is $m + 4$, that is $m + 4 \times \frac{m + 4 - 1}{2}$ times or $\frac{m + 3}{1} \times \frac{m + 4}{2}$ times; and consequently in expressing the Value of CG the Coefficient of the third Term A'I' must be $\frac{m + 3}{1} \times \frac{m + 4}{3}$.

4. Any Term of $1 \times K$ as $a b c d e f g h i k$, may be the Product of any Part of C that involves three of its Factors, and of the Part of G that involves the rest, and therefore may arise in the Product CG as often as different

1

Pro-

Products of three Quantities can be taken out of Quantities whose Number is $m + 6$ that is, $\overline{m + 6} \times \frac{m + 5}{2}$

$\times \frac{m + 4}{3}$ times, and therefore the Coefficient of the

fourth Term in the Value of CG must be $\frac{m + 4}{1} \times$

$$\frac{m + 5}{2} \times \frac{m + 6}{3}$$

In general, in expressing the Value of the Product of any two Coefficients C and G, if x express the Order of any Term of this Value as $A' I'$, that is, the Number of Terms that precede it, the Coefficient of

that Term must be $\frac{2x + m}{1} \times \frac{2x + m - 1}{2} \times$

$\frac{2x + m - 2}{3}$ &c. taking as many Factors as there are

Units in x .

COR. I. If it is required to find by this Proposition the Square of any Coefficient E, then suppose $m = 0$, the Difference of the Dimensions of the Coefficients in this Case vanishing, and we shall have $E^2 = E' \times E' +$

$$2 D' F' + 3 \times \frac{4}{2} \times C' G' + 4 \times \frac{5}{2} \times \frac{6}{3} \times B' H'$$

&c. $= E' \times E' + 2 D' F' + 6 C' G' + 20 B' H' + 70 A' I' + 252 K$. Therefore if $E' \times E'$ express the Sum of the Products of any two parts of E multiplied by each other, we shall have $E^2 = E' \times E' + 2 E' \times E'$, and therefore $E' \times E' = D' F' + 3 C' G' + 10 B' H' + 35 A' I' + 126 K$.

K

COR.

COR. II. It follows from this Proposition that

$$\begin{aligned} E^2 &= E' \times E' + 2 D' F' + 6 C' G' + 20 B' H' + 70 A' I' + 252 K. \\ D F &= - D' F' + 4 C' G' + 15 B' H' + 56 A' I' + 210 K. \\ C G &= - C' G' + 6 B' H' + 28 A' I' + 120 K \\ B H &= - B' H' + 8 A' I' + 45 K \\ A I &= - A' I' + 10 K \\ K &= - K \end{aligned}$$

COR. III. It easily appears by comparing the Theorems given in the last Corollary, that

$$\begin{aligned} E' E' &= - E^2 - 2 D F + 2 C G - 2 B H + 2 A I - 2 K. \\ D' F' &= - D F - 4 C G + 9 B H - 16 A I + 25 K \\ C' G' &= - C G - 6 B H + 20 A I - 50 K \\ B' H' &= - B H - 8 A I + 35 K \\ A' I' &= - A I - 10 K. \end{aligned}$$

P R O P. VII.

Let $l = n \times \frac{n-1}{2} \times \frac{n-2}{3}$ &c. taking as many Factors as the Coefficient E has Dimensions and $\frac{l-1}{2l} \times E^2$ shall always exceed $D F - C G + B H - A I + K$ when the Roots of the Equation are all real Quantities.

For it is manifest that l expresses the Number of Parts or Terms in the Coefficient E , and it is plain from Proposition V (See *Phil. Trans.* N° 394) that $\frac{l-1}{2l} \times E^2$ must always be greater than the Sum of the Products that can be made by multiplying any two of

of the Parts of E by each other, that is, than $E' \times E$; but $2 E' \times E = E^2 - E' E' =$ (by the first Theorem in the last Corollary) $2 DF - 2 CG + 2 BH$

$- 2 A' I + 2 K$, and therefore since $\frac{l-1}{2l} \times E^2$

must always exceed $E' E$, it follows that $\frac{l-1}{2l} E^2$

must always be greater than $DF - CG + BH - AI + K$ when the Roots of the Equation are real Quantities.

SCHOL. In following my Method this was the first general Proposition presented it self. For having first observed that if l expresses the Number of any Quantities,

the Square of their Sum multiplied by $\frac{l-1}{2l}$ must

always exceed the Sum of the Products made by multiplying any two of them by each other; and that the Excess was the Sum of the Squares of the Differences of the Quantities divided by $2l$, it was easy to see in the

Equation $x^n - A x^{n-1} + B x^{n-2} - C x^{n-3} + D x^{n-4} \&c. = 0$. Since B is the Sum of the Products of any two of the Parts of A , that if l expresses

the Number of the Roots of the Equation, $\frac{l-1}{2l} \times A^2$

must always exceed B ; and this is one Part of the 5th Proposition. In the next Place, I compared the Sum of the Products of any two Parts of B with AC , and found that it was not equal to AC but to $AC - D$ from which I inferred, that if l expresses

the Number of the Parts of B then $\frac{l-1}{2l} \times B^2$ must always exceed $AC - D$; and these easily suggested this general Proposition.

P R O P. VIII.

Let r express the Dimensions of the Coefficient C, and s the Difference of the Dimensions of the Coefficients C and G, then B and H being Coefficients adjacent to C and G, $n - r - s \times r C' G'$ shall always be greater than $s + 1 \times s + 2 \times B' H'$ when the Roots of the Equation are all real Quantities affected with the same Sign.

For taking the Differences of all those Parts of the Coefficient C that are similar in all their Factors but one, as $abc, abb, abi, \&c.$ and multiplying the Square of each Difference by such Parts of the Coefficient D (which is of s Dimensions) as are dissimilar to both the Parts of C in that Difference, the Sum of all those Squares thus multiplied, will consist of Terms of $C' G'$ taken positively, and of Terms of $B' H'$ taken negatively. By multiplying in this manner $\overline{abc - abh}^2 + \overline{abc - ab i}^2 + \overline{abc - ab k}^2 \&c. + \overline{abc - ac h}^2 + \overline{abc - ac i}^2 + \overline{abc - ac k}^2 \&c. + \overline{abc - bc h}^2 + \overline{abc - bc e}^2 + \overline{abc - bc k}^2 \&c.$ by $defg$ the Term of D, that is dissimilar to all those Parts of C, you will find that $a^2 b^2 c^2 defg$ will arise in the Sum of the Products $r \times n - r - s$ times: For those Products may be also expressed thus $defg a^2 b^2 \times \overline{c - h}^2 + \overline{c - i}^2 + \overline{c - k}^2 \&c. + defg a^2 c^2 \times \overline{b - h}^2 + \overline{b - i}^2 + \overline{b - k}^2 \&c. + defg b^2 c^2$

$defgb^2c^2 \times \overline{a-b}^2 + \overline{a-i}^2 + \overline{a-k}^2$ &c. where the Number of the Differences $c-b, c-i, c-k$, &c. whose Squares are multiplied by $defgab^2$ is manifestly equal to the Number of the Roots of the Equation that do not enter $a^2b^2c^2defg$ or $abcdefg$, that is, to the Excess of the Number of the Roots of the Equation above the Dimensions of $abcdefg$, a Term of G , that is to $n-r-s$. But in collecting all the said Products, $\overline{n-r-s} \times a^2b^2c^2defg$ must arise as often as there are Units in r : Because the Terms which are subtracted from abc may differ from it in the Root c , as abb, abi, abk , &c. or in the Root b , as acb, aci, ack , &c. or in the Root a as bcb, bci, bck ; that is, $\overline{n-r-s} \times a^2b^2c^2defg$ must arise as often as there are Dimensions in abc , a Term of C , or as often in general as there are units in r , which expresses the Dimensions of C : Therefore the Term $a^2b^2c^2defg$ will arise in the Sum of the above-mentioned Products $r \times \overline{n-r-s}$ times.

The Negative Part must consist of the Terms of $B'H'$ doubled; each of which, as $2a^2b^2c^2defg$ may arise as often as there can be Differences $c-d, c-e, c-f, c-g, d-e$, &c. assumed amongst the Terms c, d, e, f, g whose Number is equal to $s+2$ that is, $\overline{s+2} \times \frac{s+1}{2}$ times; and therefore $a^2b^2c^2defg$ or any other

Part of $B'H'$ must arise in the negative Part $\overline{s+1} \times \overline{s+2}$ times; and since the whole aggregate must be positive it follows $\overline{n-r-s} \times r C' G'$ must always exceed $\overline{s+1} \times \overline{s+2} \times B'H'$.

COR. I. Suppose we are to compare $E'E'$ the Sum of the Squares of the Parts of E with $D'F'$ the Sum of the Products of the similar Parts of D and F ; in this Case s vanishes, and therefore $\overline{n-r} \times r E'E'$ must exceed $2 D'F'$. Let $\overline{n-r} \times r = m$ and consequently $\overline{n-r-1} \times r - 1 = m - n + 1$; $\overline{n-r-2} \times r - 2 = m - 2n + 4$; $\overline{n-r-3} \times r - 3 = m - 3n + 9$; $\overline{n-r-4} \times r - 4 = m - 4n + 16$. Since it is plain that $\overline{n-r-q} \times r - q = \overline{n-r} \times r - qn + q^2$. Then by this Proposition, supposing

$$\begin{aligned} m \times E'E' - 2 D'F' &= a' \\ m \times \overline{n+1} \times D'F' - 12 C'G' &= b' \\ \overline{m-2n+4} \times C'G' - 30 B'H' &= c' \\ \overline{m-3n+9} \times B'H' - 56 A'I' &= d' \\ \overline{m-4n+16} \times A'I' - 90 K' &= e' \end{aligned}$$

The Quantities a', b', c', d', e' , must be always positive when the Roots of the Equation are real Quantities affected with the same Sign. The Coefficients prefixed to the negative Parts are the Numbers 2, 12, 30, 56, 90, whose Differences equally increase by the same Number 8.

COR. II. Supposing as before, that $\overline{n-r} \times r = m$; and also that $m \times \overline{m-n+1} = m'$; $m' \times \overline{m-2n+4} = m''$; $m'' \times \overline{m-3n+9} = m'''$ &c. it may be demonstrated after the manner of this Proposition, that if

$$\begin{aligned} m E'E' - 2 D'F' &= a' \\ m' E'E' - 2 \times 12 C'G' &= a'' \end{aligned}$$

$$\begin{aligned} m'' E'E' - 2 \times 12 \times 30 B'H' &= a''' \\ m''' E'E' - 2 \times 12 \times 30 \times 56 A'I' &= a'''' \text{ \&c.} \end{aligned}$$

Then

Then shall a', a'', a''' , &c. be always positive when the Roots are real Quantities, whether they be affected with the same, or with different Signs. The Negative Coefficients arise by multiplying those in the preceeding Corollary, 2, 12, 30, 56, 90, by one another.

P R O P. IX.

Let a', b', c', d', e' , and m express the same Quantities as in the Corollaries of the last Proposition, and $m E^2$ —

$$\overline{m + n + 1} \times D F = a' + b' + 2 c' + 5 d' + 14 e'.$$

For by Cor. ii Prop. vi.

$$E^2 = E' E' + 2 D' F' + 6 C' G' + 20 B' H' + 70 A' I' + 252 K,$$

and by the same

$$D F = \quad \quad \quad D' F' + 4 C' G' + 15 B' H' + 56 A' I' + 210 K;$$

$$\text{therefore } m E^2 - \overline{m + n + 1} \times D F = m E' E' +$$

$$\overline{m - n - 1} \times D' F' + \overline{m - 2 n - 2} \times 2 C' G'$$

$$+ \overline{m - 3 n - 3} \times 5 B' H' + \overline{m - 4 n - 4} \times$$

$$14 A' I' + \overline{m - 5 n - 5} \times 2 K = (\text{by substituting}$$

$$\text{successively for } m E' E', \overline{m - n + 1} \times D' F',$$

$$\overline{m - 2 n + 4} \times C' G', \overline{m - 3 n + 9} \times B' H',$$

$$\overline{m - 4 n + 16} \times A' I' \text{ their Values deduced from the}$$

$$\text{first Corollary of the last Proposition) } = a' + b' +$$

$$2 c' + 5 d' + 14 e', \text{ where the Coefficients prefixed}$$

$$\text{to } a' b' c' d' e', \text{ are the Differences of the Coefficients}$$

$$\text{of } E' E', D' F', C' G', B' H', A' I' \text{ and } K \text{ in the Values}$$

$$\text{of } E^2 \text{ and } D F \text{ taken from Cor. ii. Prop. vi. being } 1 - 0,$$

$$2 - 1, 6 - 4, 20 - 15, 70 - 56 \text{ and } 252 - 210.$$

COR.

COR. Since $m = \frac{n-r}{r} \times r$ therefore $m + n + 1 = \frac{n-r}{r} \times r + n + 1$; and consequently $\frac{r}{r+1} \times \frac{n-r+1}{n-r} \times E^2$ must always be greater than D F the Product of the Coefficients adjacent to E; and hence the Fractions are deduced, that in Sir Isaac Newton's Rule are placed over the Terms of the Equation, which multiplied by the Square of the Terms under them, must always exceed the Products of the adjacent Terms of the Equation, when the Roots are real Quantities: For it is manifest that the Fraction to be placed over the Term $E x^{n-r}$ according to that Rule is the Quotient of $\frac{n-r}{r+1}$ divided by $\frac{n-r+1}{r}$.

P R O P. X.

The same Expressions being allowed as in the preceding Propositions, it will be found in the same manner that as

$$\begin{aligned} m E^2 - \frac{m+n+1}{r} \times D F &= d' + b' + 2c' + 5d' + 14e' \text{ so} \\ \frac{m-n+1}{r} \times D F - \frac{m+2n+4}{r} \times C G &= -b' + 3c' + 9d' + 28e' \\ \frac{m-2n+4}{r} \times C G - \frac{m+3n+9}{r} \times B H &= -c' + 5d' + 20e' \\ \frac{m-3n+9}{r} \times B H - \frac{m+4n+16}{r} \times A I &= -d' + 7e' \\ \frac{m-4n+16}{r} \times A I - \frac{m+5n+25}{r} \times K &= -e'. \end{aligned}$$

These Theorems are easily deduced from the Theorems given in the second Corollary of Prop. vi. and the first Corollary of the viiith Proposition; and the Coefficients prefixed to d', b', c', d', e' , are the Differences of the Coefficients of the corresponding Terms in the Values of $E^2, D F, C G, B H, A I$ and K in Cor. ii. Prop. vi.

COR. Hence the Products of any two Coefficients, as DF and AI may be compared together when the Sum of the Dimensions of D and F is equal to the Sum of the Dimensions of A and I. Let the Dimensions of A and F be equal to s and m respectively, and

$$\text{let } p = \frac{n-s}{s+1} \times \frac{n-s-1}{s+2} \times \frac{n-s-2}{s+3} \text{ \&c. taking}$$

as many Factors as there are Units in the Difference

$$\text{of the Dimensions of D and A. Let } q = \frac{n-m}{m+1} \times \frac{n-m-1}{m+2} \times \frac{n-m-2}{m+3} \text{ \&c. taking as many Factors}$$

as you took in the Value of p . Then shall $\frac{q}{p} \times$

DF always exceed AI when the Roots of the Equation are real Quantities affected with the same Sign; and this Rule obtains, though the Roots are affected with different Signs when the Coefficients D and F are equal:

P R O P. XI.

The same Things being supposed as in the preceding Propositions.

$$1. \overline{mE} - \overline{m+1} \times 2 \overline{DF} + \overline{m+4} \times 2 \overline{CG} - \overline{m+9} \times \left. \begin{array}{l} 2 \overline{BH} + \overline{m+16} \times 2 \overline{AI} - \overline{m+25} \times 2 \overline{K} \end{array} \right\} = a.$$

$$2. \overline{m} - \overline{n+1} \times \overline{DF} - \overline{m-n+4} \times 4 \overline{CG} + \overline{m-n+9} \times \left. \begin{array}{l} 9 \overline{BH} - \overline{m-n+16} \times 16 \overline{AI} + \overline{m-n+25} \times 25 \overline{K} \end{array} \right\} = b.$$

$$\overline{m-2n+4} \times \overline{CG} - \overline{m-2n+9} \times 6 \overline{BH} + \overline{m-2n+16} \times \left. \begin{array}{l} 20 \overline{AI} + \overline{m-2n+25} \times 50 \overline{K} \end{array} \right\} = c.$$

$$4. \overline{m-3n+9} \times \overline{BH} - \overline{m-3n+16} \times 8 \overline{AI} + \overline{m-3n+25} \times 35 \overline{K} = d.$$

$$5. \overline{m-4n+16} \times \overline{AI} - \overline{m-4n+25} \times 10 \overline{K} = e.$$

L

These

These Theorems follow easily from the third Corollary of the vith Proposition. The first easily appears thus, $a' = mE'E' - 2D'F' =$ (by that Corollary $mE^2 - 2mDF + 2mCG - 2mBH + 2mAI - 2mK$
 $- 2DF + 8CG - 18BH + 32AI - 50K$

$$= \frac{mE^2}{m+9} - \frac{m+1}{m+9} \times 2DF + \frac{m+4}{m+9} \times 2CG - \frac{m+9}{m+9} \times 2BH + \frac{m+16}{m+9} \times 2AI - \frac{m+25}{m+9} \times 2K$$

The other Theorems are deduced from the same Corollary compared with Cor. i. Prop. viii.

P R O P. XII.

The same Things being supposed as in the second Corollary of the viiith Proposition.

$$1. \left. \begin{aligned} mE^2 - \frac{m+1}{m+9} \times 2DF + \frac{m+4}{m+9} \times 2CG - \frac{m+9}{m+9} \times 2BH + \frac{m+16}{m+9} \times 2AI - \frac{m+25}{m+9} \times 2K \end{aligned} \right\} = a$$

$$2. \left. \begin{aligned} m'E^2 - 2m'DF + \frac{m'-12}{m'-72} \times 2CG - \frac{m'-72}{m'-240} \times 2BH + \frac{m'-600}{m'-240} \times 2AI - \frac{m'-3600}{m'-240} \times 2K \end{aligned} \right\} = a''$$

$$3. \left. \begin{aligned} m''E^2 - 2m''DF + 2m''CG - \frac{m''+360}{m''+360 \times 8} \times 2BH + \frac{m''+360 \times 35}{m''+360 \times 35} \times 2AI - \frac{m''+360 \times 35}{m''+360 \times 35} \times 2K \end{aligned} \right\} = a'''$$

$$4. \left. \begin{aligned} m'''E^2 - 2m'''DF + 2m'''CG - 2m'''BH + \frac{m''' - 750}{m''' - 7200 \times 28} \times 28 \times 2AI - \frac{m''' - 7200 \times 28}{m''' - 7200 \times 28} \times 2K \end{aligned} \right\} = a''''$$

&c.

These Theorems follow from the third Corollary of the vith Proposition compared with the second Corollary of the eighth Proposition. The first is the same with the first of the last Proposition. The second is demonstrated by substituting in $m'E'E' - 24C'G' = a''$. The Values of $E'E'$ and $C'G'$ given in the third Cor.

Cor. of the vith Proposition. The third is found by substituting in $m''E'E' - 720 B'H' = a'''$ the Values of $E'E'$ and $B'H'$; and by a like Substitution these Theorems may be continued.

A General COROLLARY.

From these Propositions a great Variety of Rules may be deduced for discovering when an Equation has imaginary Roots. The Foundation of Sir *Isaac Newton's* Rule is demonstrated in the ninth Proposition, and its Corollary. The seventh Proposition shews that if $\frac{l-x}{2l} \times E'$ does not exceed $DF - CG + BH - AI + K$, some of the Roots of the Equation must be imaginary; and sometimes this Rule will discover impossible Roots in an Equation, that do not appear by Sir *Isaac Newton's* Rule. These are the only two Rules that have been hitherto published. But the Rules that arise from the Theorems in the eleventh and twelfth Propositions, are preferable to both; because any imaginary Roots that can be discovered by the vith or ixth always appear from the xith and xiith Propositions; and impossible Roots will often be discovered by the xith and xiith Propositions in an Equation, that do not appear in that Equation when examined by the vith and ixth Propositions. The Advantage which the Rules deduced from the xith Proposition, have above those deduced from the preceeding Propositions, will be manifest by considering that in the xith Proposition we have the Values of the Quantities a', b', c', d', e' , separately; whereas in the preceeding Propositions, we have only the Values of certain Aggregates of these Quantities

joined with the same Signs. Now it is obvious that if these Quantities be separately found positive, any such Aggregates of them must be positive; but these Aggregates may be positive, and yet some of the Quantities a', b', c', d', e' , themselves may be found negative: From which it follows, that if the Roots of the Equation are all affected with the same Sign, and no impossible Roots appear by Proposition xith, none will appear by the preceding Propositions; but that some imaginary Roots may be discovered by Proposition xith, when none appear in the Equation examined by the Propositions that precede the xith. If some of the Roots of the Equation are positive, and some negative (which always easily appears by considering the Signs of the Terms of the Equation) then the xiith Proposition will be in many Cases more apt to discover imaginary Roots in an Equation than those that precede it.

The Rule that flows from the first Theorem of the xith Proposition, obtains when the Roots of the Equation are affected with different Signs, as well as when they all have the same Sign, and it is this; Multiply the Number of the Terms in an Equation that precedes any Term, as $E x^{m-1}$ by the Number of Terms that follow it in the same Equation, and call the Product m . Suppose that $+D, -C, +B, -A, +I$ are the Coefficients preceeding the Term $E x^{m-1}$, and that $+F, -G, +H, -I, +K$ are the Coefficients that follow

it; then if $\frac{1}{2} m E^2$ does not exceed $m + 1 \times D F$
 $- \frac{m+4}{2} \times C G + \frac{m+9}{2} \times B H - \frac{m+16}{2} \times A I$
 $+ \frac{m+25}{2} \times K$ the Equation must have some imaginary Roots; where the Coefficients $m+1, m+4, m+9,$
 &c.

&c. are found by adding to m the Squares of the Numbers 1, 2, 3, 4, &c. which shew the Distances of the Coefficients to which they are prefixed, from the Coefficient E. The second Theorem of the xiith Proposition shews, that if $\frac{1}{2} m' E^2$ does not exceed $m' D F$

$— \frac{m'}{12} \times CG + m' — 72 \times BH — \frac{m'}{240} \times AI + \frac{m'}{600} \times K$, the Equation must have some Roots imaginary.

For an Example, If the four Roots of the Biquadratic Equation $x^4 - Ax^3 + Bx^2 - Cx + D = 0$ are real Quantities, it will follow equally from the vth, viith, ixth, and xith Propositions, that $\frac{3}{8} A^2$ must be greater than B, and that $\frac{3}{8} C^2$ must exceed B D. The

viith further shews that $\frac{5}{12} B^2$ must exceed $AC - D$;

the ixth demonstrates that $\frac{4}{9} B^2$ must exceed AC ; but

our Rule deduced from Prop xi. shews that $2 B^2$ must exceed $5 AC - 8 D$, the excess being $\frac{1}{2} a'$, and the

Rule deduced from the second Theorem of the xiith Proposition shews that B^2 must always exceed $2 AC$

+ $4 D$, the Excess being $\frac{1}{4} a''$. It appears from several

preceeding Propositions, that if the Roots of the Equation have all the same Sign, then AC must exceed $16 D$: Let the Excesses $5 B^2 - 12 AC + 12 D$

$= p$; $4 B^2 - 9 AC = q$, $AC - 16 D = s$; and it is plain that $a' (= 4 B^2 - 10 AC + 16 D) = q$

$— s$.

$$-s = \frac{2}{5} \times \overline{2p - s}; \text{ and that } a'' = q + s = \frac{2}{5} \times$$

$\overline{2p + 4s}$. Let us suppose,

1. That s is positive, then it is manifest that if either p or q be negative, a' must also be found negative, and consequently that when the viith or ixth Proposition shew any Roots to be imaginary, the xith Proposition must discover them at the same time. But as a'

$$(= q - s = \frac{2}{5} \times \overline{2p - s}) \text{ may be found negative}$$

when p and q are both positive, it follows that the Rule we have deduced from the xith Proposition may discover imaginary Roots in an Equation, that do not appear by the preceeding Propositions: Thus if you examine the Equation $x^4 - 6x^3 + 10x^2 - 7x + 1$ by Sir *Isaac Newton's* Rule, or by our viith Proposition, no imaginary Roots appear in it from

$$\text{either. But since } 2B^2 - 5AC + 8D (= \frac{1}{2}a') =$$

$200 - 210 + 8 = -2$ is in this Equation negative, it is manifest that two Roots of the Equation must be imaginary. Let us suppose

2. That s is negative, and that from the Signs of the Terms of the Equation, it appears that some Roots are positive and some negative; then in Order to see if the Equation has any imaginary Roots, the most useful Rule is that we deduced from the second Theorem of Prop. xii. *viz.* that if B^2 does not exceed $2AC + 4D$ some of the Roots of the Equation must be imaginary: For the Excess of B^2 above $2AC + 4D$ be-

$$\text{ing } \frac{1}{4}a'' = \frac{1}{4} \times \overline{q + s} = \frac{1}{10} \times \overline{2p + 4s}, \text{ and } s$$

being

being negative, it is manifest, that if q or p be negative $\frac{1}{4} a''$ must be negative; and that $\frac{1}{4} a''$ may be negative when q and p are both positive; that is, This Rule must always discover some Roots to be imaginary when the viith or ixth Propositions discover any impossible Roots in an Equation; and will very often discover such Roots in an Equation when these Propositions discover none. For Example, if you examine the Equation $x^4 + 5x^3 + 6x^2 - x - 12 = 0$, you will discover no imaginary Roots in it by the viith or ixth Propositions; and though $AC - 16D (= s)$ be negative, it does not follow, that the Equation has any impossible Roots, because it appears from the Signs of the Terms, that the Equation has Roots affected with different Signs. But since $B^2 - 2AC - 4D (= 36 + 10 - 48 = -2)$ is negative, it appears from our Rule, that the Equation must have some imaginary Roots.

I might shew in the next Place, how the Rules deduced from the xith and xiith Propositions may be extended so as to discover when more than two Roots of an Equation are imaginary, and in general to determine the Number of imaginary Roots in any Equation; but as it would require a long Discussion, and some *Lemma-ta* to demonstrate this strictly, I shall only observe that these xith and xiith Propositions will be found to be still the most useful of all those we have given for that Purpose. To give one Example of this; If we are to examine the Equation $x^4 - 4ax^3 + 6a^2x^2 - 4ab^2x + b^4 = 0$ by Sir Isaac Newton's Rule, it is found

$$\begin{array}{ccccccc} & & + & - & + & - & \\ + & b^4 & = & 0 & \text{by Sir Isaac Newton's Rule, it is found} \\ + & & & & & & \end{array}$$
to have four impossible Roots when a is greater than b ; for though the Square of the second Term multipli-

ed by $\frac{3}{8}$ be equal to the Product of the first and third Terms, yet in that Case, in applying Sir *Isaac Newton's* Rule, the Sign — ought to be placed under the second Term, and the same is to be said of the Square of the fourth Term. The Rule deduced from the viith Proposition shews four Roots imaginary, when a is greater than b , and also when b^2 is greater than $15 a^2$; but a Rule founded on the xith Proposition, shews the four Roots to be imaginary always when a exceeds b , or when b^2 exceeds $9 a^2$; from which the Excellency of this Rule above these two is manifest. I have said so much of Biquadratic Equations, that I must leave it to those that are willing to take the Trouble, to make like Remarks on the higher Sorts of Equations.

In investigating the preceeding Propositions, when I found my self obliged to go through so intricate Calculations, I often attempted to find some more easy Way of treating this Subject. The following was of considerable Use to me, and may perhaps be entertaining to you. By it, I investigate some *maxima* in a very easy Manner, that could not be demonstrated in the common Way with so little Trouble.

LEMMA V. Let the given Line AB be divided any where in P and the Rectangle of the Parts AP and P.B will be a *maximum* when these Parts are equal.

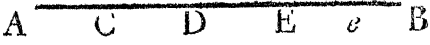


This is manifest from the Elements of *Euclid*.

LEMMA VI. If the Line AB is divided into any Number of Parts AB, CD, DE, E.B, the Product of all those Parts multiplied into one another will be a

max-

maximum when the Parts are equal amongst themselves. For let the Point D be where you will, it is manifest that if DB be bisected in E, the Product $AC \times CD \times DE \times EB$ will be

greater than $AC \times CD \times DE \times EB$  $AC \times CD \times DE \times EB$

because by the last Lemma $DE \times EB$ is greater than $DE \times EB$; and for the same reason AD and CE must be bisected in C and D; and consequently all the Parts AC, CD, DE, EB must be equal amongst themselves, that their Product may be a *maximum*.

LEMMA VII. The Sum of the Products that can be made by multiplying any two Parts of AB by one another is a *maximum* when the Parts are equal. The Sum of these Products is $AC \times CB + CD \times DB + DE \times EB$: Now that $DE \times EB$ may be a *maximum*, DB must be bisected in E by the *v*th Lemma, and for the same reason AD and CE must be bisected in C and D, that is all the Parts, AC, CD, DE, EB must be equal, that the Sum of all these Products may be a *maximum*.

LEMMA VIII. The Sum of the Products of any three Parts of the Line AB is a *maximum*, when all the Parts are equal. For that Sum is $AC \times CD \times DE + EB \times AC \times CD + AC \times DE + CD \times DE$; and supposing the Point E given, it is manifest that AE must be equally trisected in C and D that $AC \times CD \times DE$ may be a *maximum* by Lemma vi. and that $AC \times CD + AC \times DE + CD \times DE$ may be a *maximum* by Lemma viith. From which it is manifest that all the Parts AC, CD, DE, EB must be equal, that the Sum of the Products of any three of them may be a *maximum*.

LEMMA IX. It is manifest that this way of reasoning is general, and that the Sum of any Quantities being given, the Sum of all the Products that can be

made by multiplying any given Number of them by one another, must be a *maximum* when these Quantities are equal. But the Sum of the Squares, or of any pure Powers of these Quantities, is a *minimum*, when the Quantities are equal.

T H E O R E M.

Suppose $x^n - A x^{n-1} + B x^{n-2} - C x^{n-3} + D x^{n-4} - E x^{n-5} \&c. = 0$, *to be an Equation that has not all its Roots equal to one another: Let* r *express the Dimensions of any Coefficient* D , *and let*

$$l = n \times \frac{n-1}{2} \times \frac{n-2}{3} \times \frac{n-3}{4} \&c. \text{ taking as ma-}$$

ny Factors as there are Units in r ; *then shall* $\frac{l}{n^r} \times A^r$

be always greater than D , *if the Roots of the Equation are real Quantities affected with the same Sign.*

This may be demonstrated from the preceding Propositions: But to demonstrate it from the last Lemma, let us assume an Equation that has all its Roots equal to one another, and the Sum of all its Roots equal to A , the Sum of the Roots of the proposed Equation.

This Equation will be $x - \frac{1}{n} A = 0$, or

$$x^n - A x^{n-1} + n \times \frac{n-1}{2} \times \frac{A^2}{n^2} x^{n-2} - n \times$$

$$\frac{n-1}{2} \times \frac{n-2}{3} \times \frac{A^3}{n^3} x^{n-3} \&c. = 0 \text{ and if } r \text{ ex-}$$

press the Dimensions of the Coefficient of any Term of this Equation (or the Number of Terms which pre-

precede it) it is manifest that the Term it self will be

$I \times \frac{A^r}{n^r} x^{n-r}$: But by the Supposition $D x^{n-r}$ is the

Corresponding Term in the proposed Equation, and D must be the Sum of all the Products that can be made by multiplying as many Roots of that Equation by one

another, as there are Units in r ; and $\frac{I A^r}{n^r}$ must be the

Sum of the like Products of the Roots of the other Equation; which must be the greater Quantity by the preceding Lemmata, because its Roots are equal amongst themselves, and their Sum is equal to the Sum of the Roots of the proposed Equation; and the Sum of such Products is a *maximum* when the Roots are equal amongst themselves. By pursuing this Method,

it may be demonstrated that $\frac{2B}{n \times n - 1} \Big| \frac{r}{2} \times I$ must always

exceed the Coefficient prefixed to the Term x^{n-r} in an Equation whose Roots are all real Quantities affected with the same Sign; providing that r be a Number

*greater than 2; and also that $\frac{2 \times 3 C}{n \times n - 1 \times n - 2} \times I$

must exceed the same Coefficient, if r be any Number greater than 3.

It is easy to continue these Theorems.

The third Method which I mentioned in the Beginning of this Letter, is deduced from the Consideration of the Limits of the Roots of Equations; and though it is explained by some Authors already, yet as I de-

monstrate and apply it to this Subject in a different Manner, I shall add a short Account of it.

LEMMA X. If you transform the Biquadratick $x^4 - Ax^3 + Bx^2 - Cx + D = 0$ into one that shall have each of its Roots less than the respective Values of x by a given Difference e ; suppose $y = x - e$ or $x = e + y$ and the transformed Equation, the Order of the Terms being inverted, will have this Form.

$$\begin{array}{r} e^4 + 4e^3y + 6e^2y^2 + 4ey^3 + y^4 = 0 \\ - Ae^3 - 3Ae^2y - 3Aey^2 - Ay^3 \\ + Be^2 + 2Be y + B y^2 \\ - Ce - c y \\ + D \end{array}$$

Where it is manifest,

1. That the first Term $e^4 - Ae^3 + Be^2 - Ce + D$ is the Quantity that arises by substituting e in Place of x in the proposed Equation $x^4 - Ax^3 + Bx^2 - Cx + D$.

2. That the Coefficient of the second Term $4e^3 - 3Ae^2 + 2Be - C$ is the Quantity that arises by multiplying each Part of the first $e^4 - Ae^3 + Be^2 - Ce + D$ by the Index of e in that Part, and dividing the Product by e .

3. That the Coefficient of the third Term $6e^2 - 3Ae + B$ is the Quantity that arises from the preceding Coefficient $4e^3 - 3Ae^2 + 2Be - C$ by multiplying each Part by the Index of e in it, and dividing the Product by $2e$.

4. That the Coefficient of the fourth Term arises in like Manner from the preceding, only you now divide by $3e$; and in general, the Coefficient of any Term may be deduced from the Coefficient of that Term which preceeds it, by multiplying each Part of

the preceding Coefficient by the Index of e in that Part, and dividing the Product by e and by the Index of y , in the Term whose Coefficient is required.

LEMMA XI. If any Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. = 0$ be transformed in the same Manner, by supposing $x = y - e$ or $x = e + y$, and consequently $x^n = \overline{e + y}^n$, $Ax^{n-1} = A \times \overline{e + y}^{n-1}$, $Bx^{n-2} = B \times \overline{e + y}^{n-2} \&c.$ The transformed Equation will have this Form, the Order of the Terms being inverted,

$$\begin{aligned} e^n + ne^{n-1}y + n \times \frac{n-1}{2} \times e^{n-2}y^2 \&c. &= 0 \\ -Ae^{n-1} - \overline{n-1} \times Ae^{n-2}y - \overline{n-1} \times \frac{n-2}{2} \times Ae^{n-3}y^2 \&c. \\ + Be^{n-2} + \overline{n-2} \times Be^{n-3}y + \overline{n-2} \times \frac{n-3}{2} \times Be^{n-4}y^2 \&c. \\ - Ce^{n-3} - \overline{n-3} \times Ce^{n-4}y - \overline{n-3} \times \frac{n-4}{2} \times Ce^{n-5}y^2 \&c. \\ \&c. \qquad \qquad \&c. \qquad \qquad \&c. \end{aligned}$$

Where it is manifest,

1. That the first Term $e^n - Ae^{n-1} + Be^{n-2} - Ce^{n-3} \&c.$ is the Quantity that arises by substituting e in the Place of x in the proposed Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c.$

2. That the Coefficient of the second Term $\frac{ne^{n-1}}{n-3} - \overline{n-1} \times Ae^{n-2} + \overline{n-2} \times Be^{n-3} - \overline{n-3} \times Ce^{n-4} \&c.$ is deduced from the preceding $e^n - Ae^{n-1} + Be^{n-2} - Ce^{n-3} \&c.$ by multiplying each of its Parts by the Index of e in that Part, and dividing by e .

3. That

3. That the Coefficient of the third Term is deduced from the Coefficient of the second Term, by multiplying after the same manner, each of its Parts by the Index of e and dividing by $2 e$. In general, the Coefficient of any Term y^r is deduced from the Coefficient of the preceding Term, that is of y^{r-1} by multiplying every Part of that Coefficient by the Index of e in it, and dividing the Product by $r e$.

LEMMA XII. If you substitute any two Quantities K and L in the Place of x in $x^4 - A x^3 + B x^2 - C x + D$, and the Quantities that result from these Substitutions be affected with contrary Signs, the Quantities K and L must be *Limits* of one or more real Roots of the Equation $x^4 - A x^3 + B x^2 - C x + D = 0$. That is, one of these Quantities must be greater, and the other less than one or more Roots of that Equation.

For if you suppose that a, b, c, d , are the Roots of that Equation, then it is plain from the *Genesis* of Equations, that $x^4 - A x^3 + B x^2 - C x + D = \overline{x - a} \times \overline{x - b} \times \overline{x - c} \times \overline{x - d}$; and therefore K and L being substituted for x in $\overline{x - a} \times \overline{x - b} \times \overline{x - c} \times \overline{x - d}$, the Product becomes in the one Case positive, and in the other negative; so that one of the Factors $x - a, x - b, x - c, x - d$ must have a Sign when K is substituted for x in it, contrary to the Sign which it is affected with when L is substituted in it for x , suppose that Factor to be $x - b$; and since $K - b$ and $L - b$ are Quantities whereof the one is positive, and the other negative, it is manifest that b one of the Roots of the Equation must be less than one, and greater than the other of the two Quantities

ties K and L : So that K and L must be the *Limits* of the Root b .

I say further, that the Root whereof K and L are *Limits*, must be a real Root of the Equation ; for the Product of the Factors that involve impossible Roots in an Equation can never have its Signs changed by substituting any real Quantity whatsoever in place of x ; because the Number of such Roots is always an even Number, and the Product of any two of these Roots such as $x - m - \sqrt{-n}$, and $x - m + \sqrt{-n}$ is $x - m|^2 + n^2$ which must be always positive, whatever Quantity be substituted for x while n remains positive, that is, while these two Roots are impossible.

LEMMA XIII. If you substitute K and L for x in $x^n - Ax^{n-1} + Bx^{n-2} \&c.$ and the Quantities that result be affected with contrary Signs, then shall K and L be the *Limits* of one or more real Roots of the Equation $x^n - Ax^{n-1} + Bx^{n-2} \&c. = 0$. This may be demonstrated after the same Manner as the last Lemma.

THEOREM I. If a, b, c, d are the Roots of the Equation $x^4 - Ax^3 + Bx^2 - Cx + D = 0$, they shall be the *Limits* of the Roots of the Equation $4x^3 - 3Ax^2 + 2Bx - C = 0$.

Suppose a to be the least Root of the biquadrattick $x^4 - Ax^3 + Bx^2 - Cx + D = 0$, b the second Root, c the third, and d the fourth, and the Values of y in the Equation in the x^{th} Lemma, will be $a - e$, $b - e$, $c - e$, $d - e$; then by substituting successively a, b, c, d for e in that Equation of y , one of the Values of y will vanish in every Substitution, and the first Term of the Equation of y , *vis.* $e^4 - Ae^3 + Be^2 - Ce + D$ vanishing, the Equation will be reduced to a Cubick of this Form.

$$\begin{array}{r}
4e^3 + 6e^2y + 4ey^2 + y^3 = 0 \\
- 3Ae^2 - 3Aey - Ay^2 \\
+ 2Be + By \\
- C
\end{array}$$

And consequently $4e^3 - 3Ae^2 + 2Be - C$ must be the Product of the three remaining Values of y having its Sign changed; that is, it must be equal to $-\overline{b-a} \times \overline{c-a} - \overline{a \times d} - \overline{a}$ when e is supposed equal to a , it must be $-\overline{a-b} \times \overline{c-b} - \overline{b \times d} - \overline{b}$ when $e = b$; it must be $-\overline{a-c} \times \overline{b-c} - \overline{c \times d} - \overline{c}$ when $e = c$; and it must be $-\overline{a-d} \times \overline{b-d} \times \overline{c-d}$ when $e = d$. Now it is manifest that these Products $\overline{b-a} \times \overline{c-a} - \overline{a \times d} - \overline{a}$, $\overline{a-b} \times \overline{c-b} - \overline{b \times d} - \overline{b}$, $\overline{a-c} \times \overline{b-c} - \overline{c \times d} - \overline{c}$, $\overline{a-d} \times \overline{b-d} \times \overline{c-d}$ must be affected with the Signs $+$, $-$, $+$, $-$ respectively; the first being the Product of three positive Quantities, the second the Product of one negative and two positives, the third the Product of two negatives and one positive, and the fourth the Product of three negatives. Therefore since by substituting a, b, c, d for e in the Quantity $4e^3 - 3Ae^2 + 2Be - C$, it becomes alternately a positive and a negative Quantity, it follows from the last Lemma that a, b, c, d must be the *Limits* of the Roots of the Equation $4e^3 - 3Ae^2 + 2Be - C = 0$, or of the Equation $4x^3 - 3Ax^2 + 2Bx - C = 0$.

COR. It follows from this Theorem, that if a, b and c are the three Roots of the Equation $4x^3 - 3Ax^2 + 2Bx - C = 0$, they must be *Limits* betwixt a, b, c, d the Roots of the Biquadratic $x^4 - Ax^3 + Bx^2 - Cx + D = 0$: For if a, b, c, d are *Limits* of the
Roots

Roots $a', b',$ and c' ; these Roots conversely must be *Limits* betwixt a, b, c and d .

THEOREM II. Multiply the Terms of any Biquadrattick $x^4 - Ax^3 + Bx^2 - Cx + D = 0$ by any Arithmetical Series of Quantities $l + 4m, l + 3m, l + 2m, l + m, l$, and the Roots of the Biquadrattick a, b, c, d will be the *Limits* of the Roots of the Equation that results from that Multiplication that is of the Equation.

$$l x^4 - l A x^3 + l B x^2 - l C x + l D = 0 \\ + 4m x^4 - 3m A x^3 + 2m B x^2 - m C x$$

Suppose that substituting the Roots a, b, c, d of the biquadrattick Equation $x^4 - Ax^3 + Bx^2 - Cx + D = 0$ successively, for x in $4x^3 - 3Ax^2 + 2Bx - C$, the Quantities that result are $-R, +S, -T, +Z$; while $x^4 - Ax^3 + Bx^2 - Cx + D$ is in every Substitution equal to nothing; and it is manifest that the Quantity

$$+ l x^4 - l A x^3 + l B x^2 - l C x + l D \\ + 4m x^4 - 3m A x^3 + 2m B x^2 - m C x$$

will become (when a, b, c, d are substituted successively in it for x) equal to $-mRx, +mSx, -mTx, +mZx$; where the Signs of these Quantities being alternately negative and positive, it follows that a, b, c, d must be *Limits* of that Equation by Lemma xii.

COR. Hence it follows, that a, b, c and d are *Limits* of the Roots of the Cubick Equation $Ax^3 - 2Bx^2 + 3Cx - 4D = 0$, and conversely, that the Roots of this Cubick are *Limits* of the Roots of the biquadrattick Equation $x^4 - Ax^3 + Bx^2 - Cx + D = 0$, for multiplying the Terms of this biquadrattick Equation by the Arithmetical Progression $0, -1, -2, -3, -4$, the Cubick $Ax^3 - 2Bx^2 + 3Cx - 4D = 0$ arises.

THEOREM III. *In general, the Roots of the Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. = 0$, are the Limits of the Roots of the Equation $nx^{n-1} - \overline{n-1} \times Ax^{n-2} + \overline{n-2} \times Bx^{n-3} \&c. = 0$, or of any Equation that is deduced from it by multiplying its Terms by any Arithmetical Progression $1 \mp d, 1 \mp 2d, 1 \mp 3d \&c.$ and conversely the Roots of this new Equation will be the Limits of the Roots of the proposed Equation $x^n - Ax^{n-1} + Bx^{n-2} \&c. = 0$.*

This Theorem is demonstrated from the xth and xiiith Lemmata in the same manner as the preceding Theorems were demonstrated from the xth and xiith. From these Theorems it is easy to infer all that is delivered by the Writers of Algebra on this Subject.

THEOREM IV. *The Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. = 0$ will have as many imaginary Roots as the Equation $nx^{n-1} - \overline{n-1} \times Ax^{n-2} - \overline{n-2} \times Bx^{n-3} \&c. = 0$, or the Equation $Ax^{n-1} - 2Bx^{n-2} + 3Cx^{n-3} \&c. = 0$.*

Suppose that any Root of the Equation $nx^{n-1} - \overline{n-1} \times Ax^{n-2} + \overline{n-2} \times Bx^{n-3} \&c. = 0$, as p becomes imaginary, and the two Roots of the Equation $x^n - Ax^{n-1} + Bx^{n-2} \&c. = 0$, which by Theorem III. ought to be its *Limits*, cannot both be real Quantities; for it is manifest from the Demonstration of Theorem I. that if they are real Quantities, then being substituted for x in $nx^{n-1} - \overline{n-1} \times Ax^{n-2} + \overline{n-2} \times Bx^{n-3} \&c.$ the Quantities that result must have contrary Signs, and consequently the Root p , whereof they are *Limits*, must be a real Root; which

which is against the Supposition. The same is true of the Equation $Ax^{n-1} - 2Bx^{n-2} + 3Cx^{n-3} \&c. = 0$, for the same Reason.

COR. The biquadratick $x^4 - Ax^3 + Bx^2 - Cx + D = 0$, will have two imaginary Roots, if two Roots of the Equation $4x^3 - 3Ax^2 + 2Bx - C = 0$ be imaginary; or if two Roots of the Equation $Ax^3 - 2Bx^2 + 3Cx - 4D = 0$ be imaginary. But two Roots of the Equation $4x^3 - 3Ax^2 + 2Bx - C = 0$ must be imaginary, when two Roots of the Quadratick $6x^2 - 3Ax + B = 0$, or of the Quadratick $3Ax^2 - 4Bx + 3C = 0$ are imaginary, because the Roots of these quadratick Equations are the *Limits* of the Roots of that Cubick, by the third Theorem; and for the same reason two Roots of the Cubick Equation $Ax^3 - 2Bx^2 + 3Cx - 4D = 0$ must be imaginary, when the Roots of the quadratick $3Ax^2 - 4Bx + 3C = 0$, or of the quadratick $Bx^2 - 3Cx + 6D = 0$ are impossible. Therefore two Roots of the Biquadratick $x^4 - Ax^3 + Bx^2 - Cx + D = 0$ must be imaginary when the Roots of any one of these three quadratick Equations $6x^2 - 3Ax + B = 0$, $3Ax^2 - 4Bx + 3C = 0$, $Bx^2 - 3Cx + 6D = 0$ become imaginary; that is, when $\frac{3}{8} A^2$ is less than B , $\frac{4}{9} B^2$ less than

AC , or $\frac{3}{8} C^2$ less than BD .

COR. II. By proceeding in the same manner, you may deduce from any Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. = 0$, as many quadratick Equations as there are Terms excepting the first and last whose Roots must be all real Quantities, if the

proposed Equation has no imaginary Roots. The Quadratick deduced from the three first Terms $x^n - Ax^{n-1} + Bx^{n-2}$ will manifestly have this Form, $\frac{n \times n - 1 \times n - 2 \times n - 3 \&c. \times x^2 - n - 1 \times n - 2 \times n - 3 \times n - 4 \&c. \times Ax + n - 2 \times n - 3 \times n - 4 \times n - 5 \&c. \times B = 0$, continuing the Factors in each till you have as many as there are Units in $n - 2$. Then dividing the Equation by all the Factors $n - 2, n - 3 \&c.$ which are found in each Coefficient, the Equation will become $n \times n - 1 \times x^2 - n - 1 \times 2 Ax + 2 \times 1 \times B = 0$, whose Roots will be imaginary by Prop. i. when $n \times n - 1 \times 2 \times 4 B$ exceeds $(n - 1)^2 \times 4 A^2$, or when B exceeds $\frac{n - 1}{2 n} A^2$, so that the

proposed Equation must have some imaginary Roots when B exceeds $\frac{n - 1}{2 n} A^2$; as we demonstrated after

another Manner in the vth Proposition. The Quadratick Equation deduced in the same Manner from the three first Terms of the Equation $Ax^{n-1} - 2 Bx^{n-2} + 3 Cx^{n-3} \&c. = 0$, will have this Form $\frac{n - 1 \times n - 2 \times n - 3 \&c. \times Ax^2 - n - 2 \times n - 3 \times n - 4 \&c. \times 2 Bx + n - 3 \times n - 4 \times n - 5 \&c. \times 3 C = 0$; which by dividing by the Factors common to all the Terms, is reduced to $n - 1 \times n - 2 \times Ax^2 - n - 2 \times 4 Bx + 6 C = 0$, whose Roots must be imaginary when $\frac{2}{3} \times \frac{n - 2}{n - 1} \times B^2$ is less than AC ; and therefore in that case some Roots of the proposed Equation must be imaginary.

COR. III. In general, let $Dx^{n-r+1} - Ex^{n-r} + Fx^{n-r-1}$ be any three Terms of the Equation, $x^n -$

$Ax^{n-1} + Bx^{n-2} \&c. = 0$, that immediately follow one another, multiply the Terms of this Equation first by the Progression $n, n-1, n-2, \&c.$ then by the Progression $n-1, n-2, n-3, \&c.$ then by $n-2, n-3, n-4, \&c.$ till you have multiplied by as many Progressions as there are Units in $n-r-1$: Then multiply the Terms of the Equation that arises, as often by the Progression $0, 1, 2, 3 \&c.$ as there are Units in $r-1$, and you will at length arrive at a Quadratick of this Form,

$$\frac{n-r+1 \times n-r \times n-r-1 \times n-r-2 \&c. \times r-1}{\times r-2 \times r-3 \times r-4 \&c.} Dx^2$$

$$\frac{-n-r \times n-r-1 \times n-r-2 \times n-r-3 \&c.}{\times r \times r-1 \times r-2 \times r-3 \&c.} \times Ex$$

$$+ \frac{n-r-1 \times n-r-2 \times n-r-3 \times n-r-4 \&c.}{\times r+1 \times r \times r-1 \times r-2 \&c.} \times F = 0,$$

and dividing by the Factors $n-r-1, n-r-2, \&c.$ and $r-1, r-2 \&c.$ which are found in each Coefficient, this Equation will be reduced to $\frac{n-r+1}{\times n-r \times 2 \times 1 \times D} x^2 - \frac{n-r \times 2 \times r \times 2}{2 \times 1 \times r+1 \times F} Ex +$ whose Roots must be ima-

ginary (by Prop i.) when $\frac{n-r}{n-r+1} \times \frac{r}{r+1} \times E^2$ is less than $D F$. From which it is manifest that if you divide each Term of this Series of Fractions $\frac{n}{1}, \frac{n-1}{2},$

$$\frac{n-2}{3}, \frac{n-3}{4}, \&c. \frac{n-r+1}{r}, \frac{n-r}{r+1}$$

by that which preceeds it, and place the Quotients above the Terms of the Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. =$

&c. = 0, beginning with the second: Then if the Square of any Term multiplied by the Fraction over, it be found less than the Product of the adjacent Terms, some of the Roots of that Equation must be imaginary Quantities. There remain many things that might be added on this Subject, but I am afraid you will think I have said as much of it as it deserves; and therefore I shall only add the Demonstration of some Algebraick Rules and Theorems that are very easily deduced from the xth Lemma.

I. The Rule for discovering when two or more Roots of an Equation are equal, immediately follows from that Lemma, Suppose that two Roots of the Equation $x^n - Ax^{n-1} + Bx^{n-2} - Cx^{n-3} \&c. = 0$ are equal, and two Values of y (which is equal always to $x - e$) will be equal. Suppose that e is equal to one of those two equal Values of x ; and two Values of y will vanish, and consequently y^2 must enter each of the Terms of the Equation of y ; and therefore in this Case the first and second Term of the Equation of y in Lemma xth must vanish, that is, $e^n - Ae^{n-1} + Be^{n-2} - Ce^{n-3} \&c. = 0$ and $ne^{n-1} - (n-1) \times Ae^{n-1} + (n-2) \times Be^{n-2} - (n-3) \times Ce^{n-3} \&c. = 0$ at the same time; and consequently these two Equations must have one Root common, which must be one of those Values of x that were supposed equal to each other. It is manifest therefore that when two Values of x are equal in the Equation $x^n - Ax^{n-1} + Bx^{n-2} \&c. = 0$, one of them must be a Root of the Equation $nx^{n-1} - (n-1) \times Ax^{n-2} + (n-2) \times Bx^{n-3} \&c. = 0$.

If three Values of x be supposed equal amongst themselves and to e , then three Values of y ($= x - e$) will vanish, and the first three Terms of the Equation of y

in Lemma xi. will vanish, and therefore $\frac{n \times n - 1}{n - 1} \times e^{n-2} - \frac{n - 1}{n - 1} \times \frac{n - 2}{n - 2} \times A e^{n-3} + \frac{n - 2}{n - 2} \times \frac{n - 3}{n - 3} \times B e^{n-4} \&c. = 0$; and one of the equal Values of x will be a Root of this last Equation, and two of them will be Roots of the Equation $n x^{n-1} - \frac{n - 1}{n - 1} \times A x^{n-2} + \frac{n - 2}{n - 2} \times B x^{n-3} \&c. = 0$. In general, it appears that if the Equation $x^n - A x^{n-1} + B x^{n-2} \&c. = 0$ have as many Roots equal amongst themselves as there are Units in S , then shall as many of those be Roots of the Equation $n x^{n-1} - \frac{n - 1}{n - 1} \times A x^{n-2} + \frac{n - 2}{n - 2} \times B x^{n-3} \&c. = 0$ as there are Units in $S - 1$; as many of them shall be Roots of the Equation $\frac{n \times n - 1}{n - 1} \times x^{n-2} - \frac{n - 1}{n - 1} \times \frac{n - 2}{n - 2} \times A x^{n-3} + \frac{n - 2}{n - 2} \times \frac{n - 3}{n - 3} \times B x^{n-4} \&c. = 0$, as there are Units in $S - 2$; and so on.

II. The general Rule which Sir *Isaac Newton* has given in the *Article de limitibus Equationum* for finding a *Limit* greater than any of the Values of x immediately follows from the xith Lemma; for it is manifest that if e be such a Quantity as substituted in all the Coefficients of the Equation of y , viz. in $e^n - A e^{n-1}$

$$+ B e^{n-2} \&c. \quad n e^{n-1} - \frac{n - 1}{n - 1} \times A e^{n-2} + \frac{n - 2}{n - 2} \times B e^{n-3} \&c. \quad n \times \frac{n - 1}{2} \times e^{n-2} - \frac{n - 1}{n - 1} \times \frac{n - 2}{2} \times A e^{n-3} + \frac{n - 3}{n - 2} \times B e^{n-4} \&c.$$

gives the Quantities that result all positive; then there being no Changes of the Signs of the Equation of y in this case, all its Values must be negative; and since y is always equal to $x - e$ it follows that e must be a greater Quantity than any of the Values of x ; that is, it must be a

Limit greater than any of the Roots of the Equation
 $x^n - Ax^{n-1} + Bx^{n-2} \&c. = 0.$

III. From this x^{th} Lemma some important Theorems in the Method of *Series*, and of *Fluxions*, and the Resolution of Equations are demonstrated with great Facility; it is obvious that the Coefficient of the second Term of the Equation of y in that Lemma is the *Fluxion* of the first Term divided by the *Fluxion* of e ; the Coefficient of the third Term is the second *Fluxion* of that first Term divided by $2\dot{e}^2$, supposing e to flow uniformly. The third Term is the third *Fluxion* of the first Term divided by $2 \times 3 \dot{e}^3$; and so on. Therefore supposing $e^n - Ae^{n-1} + Be^{n-2} \&c. = c$, the

Equation for determining y will be $c + \frac{\dot{c}}{\dot{e}}y + \frac{\ddot{c}}{1 \times 2 \dot{e}^2}y^2$

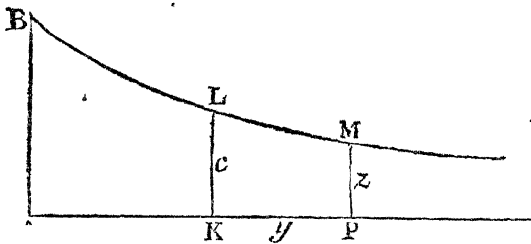
$+ \frac{\ddot{\ddot{c}}}{1 \times 2 \times 3 \dot{e}^3}y^3 \&c. = 0$; and hence, when e is near the true Value of x , Theorems may be deduced for approximating to y , and consequently to x , which is supposed equal to $y + e$.

IV. Let $AP (= x)$ be the Absciss and $PM (= z)$ the Ordinate of any Curve BLM ; and suppose any other Absciss $AK = e$ and Ordinate $KL = c$, then

shall $z (= PM) = c + \frac{\dot{c}}{\dot{e}}y + \frac{\ddot{c}}{2\dot{e}^2}y^2 + \frac{\ddot{\ddot{c}}}{2 \times 3 \dot{e}^3}y^3$
 $+ \frac{\ddot{\ddot{\ddot{c}}}}{2 \times 3 \times 4 \dot{e}^4}y^4 \&c.$

For let z be supposed equal to any Series consisting of given Quantities, and the Powers of x , as to $Ax^n + Bx^r + Cx^s \&c.$ and substituting $e + y$ for x , we shall find after the manner of the x^{th} Lemma,

$$\begin{aligned}
z &= A e^x \mp n A e^{x-1} y + n \times \frac{n-1}{2} \times A e^{x-2} y^2 \&c. \\
&+ B e^x \mp r B e^{x-1} y + r \times \frac{r-1}{2} \times B e^{x-2} y^2 \&c. \\
&+ C e^x \mp s C e^{x-1} y + s \times \frac{s-1}{2} \times C e^{x-2} y^2 \&c. \\
&\quad \&c. \quad \quad \&c. \quad \quad \&c.
\end{aligned}$$



But when $x = e$ then $z = c = A e^n + B e^r + C e^s \&c.$
 $\dot{c} = n A e^{n-1} \dot{e} + r B e^{r-1} \dot{e} + s C e^{s-1} \dot{e} \&c.$
 $\ddot{c} = n \times n-1 \times A e^{n-2} \dot{e}^2 + r \times r-1 \times B e^{r-2} \dot{e}^2$
 $+ s \times s-1 \times C e^{s-2} \dot{e}^2 \&c.$ and therefore $z = c \mp$
 $\frac{\dot{c}}{\dot{e}} y + \frac{\ddot{c}}{2 \dot{e}^2} y^2 \mp \frac{\ddot{\ddot{c}}}{2 \times 3 \dot{e}^3} y^3 \&c.$ After the same

manner you will find that $c = z \pm \frac{\dot{z}}{\dot{x}} y + \frac{\ddot{z}}{2 \dot{x}^2} y^2$
 $\pm \frac{\ddot{\ddot{z}}}{2 \times 3 \dot{x}^3} y^3 \&c.$ for $c = A e^n + B e^r + C e^s \&c. =$

$$A \times \overline{x \pm y}^n + B \times \overline{x \pm y}^r + C \times \overline{x \pm y}^s \&c. = z \pm \frac{\dot{z}}{\dot{x}} y + \frac{\ddot{z}}{2 \dot{x}^2} y^2 + \frac{\ddot{\ddot{z}}}{2 \times 3 \dot{x}^3} y^3 \&c.$$

$+\frac{\ddot{z}}{2x^2}y^2 \&c.$ The Area KLMP is equal to the Flu-
ent of xy or of $\dot{c}y$, but

$$c\dot{y} = xy \pm \frac{\dot{z}}{x}y\dot{y} + \frac{\ddot{z}}{2x^2}y^2\dot{y} \pm \frac{\ddot{z}}{2 \times 3 x^3}y^3\dot{y} \&c.$$

$$\text{and } x\dot{y} = c\dot{y} \mp \frac{\dot{c}}{\dot{e}}y\dot{y} + \frac{\ddot{c}}{2\dot{e}^2}y^2\dot{y} \mp \frac{\ddot{c}}{2 \times 3 \dot{e}^3}y^3\dot{y} \&c.$$

And consequently by finding the Fluents

$$\text{KLMP} = cy \mp \frac{\dot{c}}{2\dot{e}}y^2 + \frac{\ddot{c}}{2 \times 3 \dot{e}^2}y^3 \mp \frac{\ddot{c}}{2 \times 3 \times 4 \dot{e}^3}y^4 \&c.$$

$$\text{or KLMP} = xy \pm \frac{\dot{z}}{2x^2}y^2 + \frac{\ddot{z}}{2 \times 3 x^3}y^3 \pm \frac{\ddot{z}}{2 \times 3 \times 4 x^4}y^4 \&c.$$

This last is the Theorem published by the learn-
ed Mr. *Bernouilli* in the *Acta Lipsiæ* 1694. It is
now high Time to conclude this long Letter; I beg
you may accept of it as a Proof of that Respect and
Esteem with which

I am,

S I R,

Your most Obedient,

Most Humble Servant,

Colin Mac Laurin.

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *May* and *June*, 1729.

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L O N D O N :

Printed for W. INNES, at the *West-End* of St. Paul's Church-Yard.

- I. *An Account of the Cinnamon Tree in Ceylon, and its several Sorts. Communicated by the Chief Inspector of the Cinnamon Trade and Manufacture in that Island to Albertus Seba, a noted Druggist at Amsterdam. Translated by the late Dr. Scheuchzer, F. R. S.*

THE first and best Sort of Cinnamon, which grows in great Plenty in *Ceylon*, and is peculiar to that Island, is call'd by the Natives *Rasse Coronde*, which is as much as to say, sharp, sweet Cinnamon. 'Tis this choice Sort, which is exported Yearly by the *Dutch East-India-Company*, by whom it hath been prohibited under severe Penalties, that no other Sort whatever should be mix'd with it.

The second Sort is call'd *Canatte Coronde*, that is, bitter and adstringent Cinnamon; for the *Ceylonefe*, in their Language, call Cinnamon in general *Coronde*, and *Canatte* signifies bitter and adstringent. The Bark of this Tree comes off very easily, and smells very agreeably when fresh, but hath a bitter Taste. It is an Advantage to us, that it doth not grow in great Plenty hereabouts, because else one might easily mistake it for a better; as indeed, in general, it requires a good deal of Skill and Attention so to distinguish the Cinnamon Trees from each other, as not to choose now and then a worse Sort for the best. The Root of this second Tree yields a very good sort of Camphire.

The third Sort is call'd by the *Ceyloneſe*, *Cappe-roë Coronde*, which is as much as to ſay, Camphorated Cinnamon, becauſe it hath a very ſtrong Smell and Taſte of Camphire. It grows plentifully enough in the Iſland, but not in the Eaſtern Parts of it: However, they find Means now and then to ſend it over privately, and ſell it to the *Danes* and *Engliſh*, who come to Trade upon the Coaſts of *Cormandel*; for as long as there is but one Port in the Iſland left open, abundance of this ſort of bad Merchandize may be exported. Beſides, there is a ſort of a *Canella*, growing upon the Continent of *India*, about *Goa*, which is very like this ſort of Cinnamon Tree, though it hath nothing of the true Cinnamon. The ſame ſort of *Canella* agrees in many Things with the *Canella Malabarica Sylveſtris*, a wild Cinnamon Tree, growing upon the Coaſts of *Malabar*. And although with regard to the Shape of the Tree, and the outward Appearance of the Bark and Leaves, there is very little Difference to be obſerved between theſe two ſorts of *Canella*, and the above-mentioned firſt and good ſort of Cinnamon, yet the latter is vaſtly ſuperior in Richneſs, Virtue and Sweetneſs.

The fourth Sort of Cinnamon is called by the *Ceyloneſe*, *Welle Coronde*, that is, the *Sandy Cinnamon*, becauſe upon chewing it, one feels as it were, Bits of Sand between the Teeth, though in Fact there is nothing Sandy in it. The Bark of this Tree comes off eaſily enough, but is not ſo eaſily roll'd up into a tubular Form, as other ſorts of Cinnamon are, being apt to burſt open and to unfold it ſelf. It is of a ſharp and bitteriſh Taſte, and the Root of it yields but a ſmall Quantity of Camphire.

The fifth Sort is called *Sewel-Coronde*, *Sewel* in the *Ceyloneſe* Language ſignifies mucilaginous, or glutinous. This ſort of Cinnamon acquires, in drying, a very conſiderable Degree of Hardneſs, which upon chewing of it ſufficiently ſhews it ſelf. It hath otherwiſe but little Taſte, and an ungrateful Smell; but the Colour of it is very fine, and it is not many Years ſince I firſt took Notice, that the Natives, who are all Blacks, mix a good deal of this mucilaginous Cinnamon along with the firſt and beſt Sort, the Colour of both being very much alike, excepting only, that in the good Sort there are ſome few yellowiſh Spots appear towards the Extremities.

The ſixth Sort is called by the Natives *Nieke Coronde*, the Tree which bears it, having a good deal of Reſemblance to another Tree, which is by them called *Nieke Gas*, and the Fruit it bears *Nieke*. The Bark of this ſort of Cinnamon Tree, hath no manner of Taſte or Smell, when taken off, and is made uſe of by the Natives only in Phyſick. For by roaſting of it they obtain a Water and Oil, which they anoint themſelves withal, thinking thereby to keep off all ſorts of noxious Fumes, and Infections in the Air. They likewiſe expreſs a Juice out of the Leaves of it, which they ſay cools and ſtrengthens the Brain, if the Head be rubb'd with it.

The ſeventh Sort is called *Darwel-Coronde*, that is, Drum-Cinnamon, in *Low Dutch* *Trommel-Ganeel*: The Reaſon of this Appellation is, becauſe the Wood of this Tree, when it is grown hard enough, is light and tough, and that Sort, of which the Natives make ſome of their Veſſels and Drums, which they call *Darwel*. The Bark is taken off, when the Tree

grows as yet, and is of a pale Colour: The Natives use it in the same Manner with the sixth Sort.

The eighth Sort is called *Catte-Coronde*, that is, the thorny or prickly Cinnamon; *Catte*, in the *Ceylonefe* Language, is a Thorn, or Prickle; accordingly this Tree is very prickly. The Bark is in some Measure like Cinnamon, but the Leaves differ very much, and the Bark it self hath nothing either of the Taste or Smell of Cinnamon. The Natives use the Root, Bark and Leaves of this Tree in Physick, applying them in Form of Cataplasms, to Tumours and Swellings from a thick corrupt Blood, which they say it cures in a short Time.

The ninth Sort is called *Mael Coronde*, or the Flowering Cinnamon, because this Tree is always in Blossom. The Flowers come nearest to those of the first and best Sort, called *Rasse Coronde*, but they bear no Fruit, which the other doth. The Substance of the Wood becomes never so solid and weighty in this, as in the other Cinnamon Trees above-mentioned, which have sometimes eight, nine, or ten Feet in Circumference. If this everflowering Cinnamon Tree be cut, or bored into, a limpid Water will issue out of the Wound, as it doth out of the *European Birch Tree*, but it is of no Use, no more than the Leaves and Bark.

The Inhabitants of *Ceylon* say, that there is still another Sort of Cinnamon, which they call *Toupat Coronde*, or the three Leave Cinnamon. It doth not grow in that Part of the Country which the *Dutch East-India Company* is possess'd of, but higher up towards *Candia*. Having never seen it my self, I will also, out of regard to Truth, say nothing farther of it.

And

And thus, Sir, I have given you, I hope, a satisfactory Account of the several Sorts of Cinnamon Trees growing in this Country. I can assure you, that you are the first to whom I ever communicated so particular a Description; for having been for almost these fifteen Years last past, employed as chief Inspector of the Cinnamon Trade and Manufacture here, I have with much Pains and Attention, so strictly enquired into this Matter, that at last I found out all the several sorts of bad Cinnamon, which were formerly mix'd with the true and good one; and have been able to shew Samples of the Bark, Root and Leaves of every one of them to our Directors, who thereupon, to shew their Satisfaction, that a Thing of that Consequence was at last, after many laborious Searches discovered, and thinking it a Thing well worth a farther Enquiry, were pleased to augment the Yearly Salary annex'd to this Office.

It now remains, that I should inform you, in how many Years the Cinnamon Trees grow ripe enough, and become fit to have the Bark stript off. And here I will confine my self only to the first and best Sort, which is Yearly exported by the Company, and what I shall mention of it, may serve at the same Time to answer in some Measure such Queries as might be made about the others.

All the several sorts of Cinnamon Trees, the best as well as the rest, must grow a certain Number of Years, before the Bark is fit to be taken off: With this Difference however, that some of the Trees of the same sort, as for Instance of the first and best, will ripen two or three Years sooner than others, which is owing to the Difference of the Soil they grow in; those for Instance,

stance, which grow in Vallies, where the Ground is a fine whitish Sand (and there are many such Vallies in the Island of *Ceylon*) will in five Years Time be fit to have the Bark taken off: Others on the contrary, which stand in a wet slimy Soil, must have seven or eight Years Time to grow, before they are ripe enough. Again, those Trees are later, which grow in the Shade of other larger Trees, whereby the Sun is kept from their Roots: And hence also it is, that the Bark of such Trees hath not that Sweetness and agreeable Taste observable in the Bark of those Trees which grow in a white Sandy Ground, where with little Wet they stand full exposed to the Sun, but is rather of a bitterish Taste, something adstringent, and smells like Camphire.

For by the Heat of the Sun's Rays the Camphire is made so thin and volatile, that it rises up and mixes with the Juices of the Tree, where it undergoes a small Fermentation, and then rising still higher between the Substance of the Wood, and the thin inner Membrane of the Bark, it is at last so effectually diffused through the Branches and Leaves, that there is not the least Footstep of it to be perceived any where. Mean while that thin and glutinous Membrane, which lines the Bark on the Inside between it and the Substance of the Wood, attracts and sucks in all the purest, sweetest, and most agreeable Particles of the Juice, leaving the thick and gross ones, which are push'd forward, and serve to nourish the Branches, Leaves, and Fruit.

What I here mention, is conform to my own Observations, and I have often had Occasion to prove this Fact to curious Persons by the Things themselves. For if the Bark be fresh taken off, that Juice which
remains

remains in the Tree hath a bitterish Taste, not unlike that of Cloves. On the contrary, if you taste the inner Membrane of the Bark, when fresh taken off, you'll find it a most exquisite Sweetness, extremely agreeable to the Taste, whereas the outward Part of the Bark differs but very little in Taste from the common Trees; which shews plainly that all the Sweetness of it is owing only to the inner Membrane. But when the Bark is laid in the Sun in order to its being dried and wound up, this Oily and agreeable Sweetness of the inner Membrane communicates and diffuses it self also throughout the whole outward Part of it (which however hath been first stripp'd, when as yet upon the Tree, of its outermost greenish Coat) and imbues it so strongly, as to make the Bark a Commodity, which for the Fragrancy of its Smell, and the Sweetness of its Taste, is coveted all over the World.

It may not be amiss to take Notice also, how many Years the Cinnamon Trees, when they are once come to a full Maturity, will continue in that State, so that the Bark, when taken off, shall have lost nothing of its Sweetness and Virtue. And in order to clear up this Point, it must be observed, that the Bark may as yet be taken off from Trees which have stood fourteen, fifteen, or sixteen Years, according to the Quality of the Soil they stand in: But beyond that Time they grow thicker, and lose, by Degrees, their Taste and agreeable Sweetness, which makes the Bark have more of the Taste of Camphire: Besides, the Bark is then grown so thick, that if it be laid in the Sun, it will no longer shrink and wind it self up, but remain flat.

And here it may be thought a fit Subject of Enquiry, how it comes to pass, that considering what vast Quantities of Cinnamon have been exported from this Island, and sold all over the World, by the *Europeans* as well as Natives, not only for these two hundred Years last past; and since the Way thither by the *East-Indies* hath been found out by the *Portuguese*, but for several Centuries before (for it was discovered and known long before) I say, how, considering this, it comes to pass, that there are yet such Numbers of good Trees fit to be Bark'd, remaining in the Island and growing there every Year? Now in order to solve this Question, several Authors, who describ'd the Island of *Ceylon*, committed a considerable Mistake, when they assure their Readers, that when the Bark hath been stripp'd off the Tree, it grows again in four or five Years, and becomes fit to be stripp'd a second Time. I can assure you, Sir, that this Assertion is entirely contrary to the Course of Nature and Observation: Nor do I believe, that there is any one Tree whatever in any Part of the World, which, if it was entirely stripp'd of its Bark, could subsist and grow any longer: That Part at least, where the Bark hath been taken off, will quickly grow dry, and so die away; but the Root in the mean while remains entire and in good Condition; and this shews the Reason why there is such a Number of Trees fit to be Bark'd every Year. For although the Cinnamon Trees, after the Bark hath been once taken off, is cut down to the very Root, as they do in *Europe* Oaks, Birch-Trees, Alders and Willows, yet the Root will quickly push forth new Shoots, which will ripen in a short Time, I mean in five, six, seven or eight Years, some sooner, some later, and then yield their Quantity

tity of the Bark.. Hence it appears, how far the old Roots are instrumental to the Growth and Plenty of Cinnamon Trees, but the Fruit which falls from the Trees, contributes very much towards the same End: And it is particularly owing to a certain kind of wild Doves, which from their feeding on the Fruit of the Cinnamon-Tree, they call *Cinnamon-eaters*, that these Trees grow so plentifully in this Island; for the Doves, when they fetch Food for their young ones, flying here and there, disperse vast Quantities of the Fruit all over the Fields, which occasions the Rise of many thousand young Trees, which one shall see here and there along the Roads in such Quantities together, that they look like a little Wood. So plentifully grows this excellent Tree in this Island; I call it excellent, because indeed I don't know of any other that is preferable to it. I need not point out to you what remarkable Foot-steps of Divine Providence the History of the Cinnamon Tree affords to an attentive Eye.

There is hardly any thing so universally grateful, and esteemed by all Nations, as true Cinnamon. The Oil drawn out of it by Fire is reckoned one of the strongest Cordial Medicines: The Camphire which comes out of the Root, is likewise of great Use in several Distempers, as are also the Oil of Camphire, a very costly Thing, the Leaves of the Tree, and the Oil distilled out of them; and lastly, the Fruits with their Oil. In short, there is no Part of the Cinnamon Tree, but what is of some singular Use or other in Physick. I purposely avoid speaking of the large Gains the Company makes by the yearly Export of this precious Commodity.

Some Additions to the foregoing Account, by
 Albertus Seba. F. R. S

AS a farther Explanation of this curious Account of the Cinnamon Trees, it will not be amiss to subjoin the following Observations. Having some Years ago bought out of the *East-India* Company's Warehouses at *Amsterdam*, a considerable Quantity of Cinnamon Leaves, or *Folia Malabathri*, pack'd up in several large Chests, I happen'd to find in one of them the Flowers of the Cinnamon, as big as the *Italian* Bean-flowers, and of a blue Colour; I chanced likewise to meet with the Fruit. But I could not find either in any of the other Chests.

In 1722 and 1723, I bought of the same Company the Oil, which is expressed out of the Fruit of the Cinnamon Tree, as also that which is boil'd out of them, which is of a very good Consistence and white, and is by the *East-India* Company called Cinnamon Wax, because the King of *Candia* causes Candles to be made out of it, which for their agreeable Scent, are burnt only by himself and at his Court. However he permits his Subjects to express the Juice out of another Fruit, not unlike the Fruit of the Cinnamon Tree; but this Juice being only a thin fat Substance, like Oil of Olives, they cannot burn it any otherwise but in Lamps.

The *Indians* use this Cinnamon Wax also in Physick, and give it inwardly in Luxations, Fractures, Falls, Contusions and Bruises, that in case any inward Part be touch'd or bruised, it may by its Balsamick

Virtues heal them. They give it also in Bloody Fluxes to one Dram or a Dram and a half. Outwardly applied, it makes the Skin more beautiful, smooother and softer, than any one known sort of Pomade.

The Leaves of the Cinnamon Tree yield also an Oil, which is of a bitterish Taste, resembling Oil of Cloves mix'd with a little good Oil of Cinnamon. It is called *Oleum Malabathri*, or Oil of Cinnamon Leaves. It is an Aromatick, and is reckoned an excellent Remedy in Headaches, Pains of the Stomach, and other Distempers.

The Oil of the Root of the Cinnamon Tree is, properly speaking, an Oil of Camphire, the Roots affording a good Quantity of Camphire. About two Years ago, or somewhat longer, I bought a Bottle of it of our *East-India* Company at my own Price. There were several Bottles together in a Box, upon which was wrote in Low Dutch *Deze Oliteyten sijn tot een geschenk nyt Candia geschikt*; that is, *these Oils were sent as a Present out of Candia*, which shews that they are genuine, without any Adulteration; accordingly they are very much esteemed. If this Oil be distilled in Glasse Vessels, there comes over along with it, that sort of Camphire which the *Indians* call *Camphire Baros*, or Camphire of *Borneo*, which shoots in thin transparent Chrystals, forming a beautiful Variety of Trees on the Recipient, not unlike those, which in very frosty Weather are to be seen upon Windows. This sort of Camphire is of very great Efficacy in Physick, and is gathered and kept for the King of *Candia* his own Use, who esteems it an excellent Cordial Medicine. But not only the Camphire of *Baros*, but also the Oil of Cam-

phire, which is drawn out of the Roots of the Cinnamon Tree, is a very great Cordial, if taken inwardly : It strengthens the Stomach, expels Wind, and hath been found of great Use in arthritick and gouty Disorders : It is also a Diuretick. The Dose is ten or twelve Drops upon a bit of Sugar, or in a proper Vehicle. Outwardly it is applied in all arthritick Pains from Cold and Obstructions, being rubb'd on the affected Part with a warm Hand, and it will presently lessen the Pain, and by Degrees take it off. It is now about six and thirty Years since, serving in the Shop of Mr. *Nicolas Dumbstдорff* at *Amsterdam*, that Gentleman was then so cruelly afflicted with arthritick Pains, that he could have no Rest neither Night nor Day ; and although he called in the Assistance of several noted Physicians, and tried abundance of Medicines, yet he could find no Relief, till he was advised to cause himself to be anointed with the Oil of the Root of the Cinnamon Tree ; of which he then happen'd to have a good Quantity by him. I remember very well, that I anointed him my self, rubbing the Oil on all the affected Parts with my Hand warm'd by holding it to an Oven, and this I did twice every Day for an Hour together. And though, when this Cure was first begun with him, his Hands and Feet were by the Convulsions, and the Violence of his Pain so contracted, that they grew quite crooked, and were full of Nodes, yet in a Fortnight's Time he grew so much better, that he could sleep well at Night, feeling neither Pains nor Cramps. In about six Weeks Time he could walk about his Room, whereas before the Anointing he was not able to stir either Hand or Foot. This Anointing was continued for about three Months, when the Patient not only recover'd of that

that violent Indisposition, but continued free from the Gout ever after, and lived about fifteen Years in a very good State of Health. And this I cannot only affirm to be true of my own certain Knowledge; but also, that since that Time I have advised several People in his Condition to do the same with as good Success. Several Physicians have wrote largely of the Virtues of common Camphire, but there are as yet many hidden Qualities in this excellent Medicine. Thus, for Instance, I can affirm, that in all Burnings, by Fire or otherwise, in any Part of the Body, and the Pains occasioned thereby, I have not yet met with any better and surer Medicine than this following.

Rx. Spir. Lumbricor. terrestr. cum Spir. Vinæ rectificat ʒxij. Camphor. ʒij. M.

No sooner is a Bandage, or Compress, dipp'd into this Spirit, applied to the affected Part, but it will give instant Relief, and so effectually check the Inflammation, that it will creep no farther. But the Application of it must be continued till the Pain is quite gone, and the *Ulcus*, if there hath been any, is dried up. If the Exulceration is got deeper, and the Wound must be kept open, two Ounces of Camphire dissolved in *Oleo Hyperici*, mix'd with a Pound of the common *Unguentum Cerussæ*, applied according to Art, will quickly and effectually heal it, as I have often experienced.

II. *The Bills of Mortality in several Parts of Europe, for the Years 1724 and 1725. Extracted from the Acta Breslaviensia, by the Same.*

For the Year 1724.

A List of those that were Born and Buried at Breslaw in the Year 1724.

Persons.		Among the Dead were,	
From the 25th to the	} 17	Married Men	231
31st of Dec. 1723.		Married Women	148
January 1724.	115	Widows and Widowers	154
February	101	Batchelors	57
March	129	Maidens	66
April	79	Children to 10	} Boys 417 Years of Age. } Girls 326
May	122		
June	99	Still-born	{ Boys 36 Girls 31
July	129		
August	177	Total	1466
September	141	<i>Chriftened</i>	
October	134	Males	709
November	126	Females	613
1 Dec. to 24 Dec.	97	Total	1322
Sum Total	1466	Married	386 Pairs.

In *Vienna*.

<i>Buried</i> 5524, among whom	3	of 90 ¹	
	2	— 92	
	2	— 93	
	5	— 95	
	2	— 96	
	1	— 97	Years of Age.
	3	— 98	
	1	— 99	
	2	— 100	
	3	— 101	
	2	— 103	
	1	— 106	
<i>Christened</i> 4427.	27	of 90 and upwards.	

At *Lübau*.

<i>Buried</i>	135	
<i>Christened</i>	166	
<i>Married</i>	38	Pairs

At *Lauban*.

<i>Christened</i>	
Boys	107
Girls	116
Total	223

Buried

<i>Buried</i>	Married Men	29
	Married Women	19
	Batchelors	7
	Maidens	15
	Children	{ Boys 68
		{ Girls 61
	Infants	23
	Still-born	17
	Widows and	{
	Widowers	{ 18

257. Among which there
died 97 Children of the *Small-Pox*.

There were married 73 Couple.

At *Dresden*

<i>Christened</i>	Boys	715
	Girls	712
	Bastards	{ Boys 60
		{ Girls 70
	Total	<hr/> 1557

<i>Buried</i>	Married Men	161	
	Married Women	151	
	Widowers	35	
	Widows	143	
	Batchelors	72	
	Maidens	71	
	Children	{ Boys	522
		{ Girls	508
	Still-born	{ Boys	58
		{ Girls	40
	Total	1761.	Being 204 more than were Christened.

Married Couple 413.

At *Leipsick*.

<i>Christened in</i>	<i>January</i>	79	<i>in July</i>	78
	<i>February</i>	71	<i>August</i>	94
	<i>March</i>	99	<i>Sept.</i>	79
	<i>April</i>	78	<i>October</i>	79
	<i>May</i>	74	<i>November</i>	50
	<i>June</i>	69	<i>December</i>	63
				443
				470
			Total	913

Christened in all 913. Boys 491, Girls 422 ; among whom there were three Children at one Birth, born the 31st of *October*, one being alive, the two others Still-born, besides 14 Twins.

<i>Buried in</i>	<i>January</i>	53	Among which	{ Married Men	122
	<i>February</i>	78		Married Women	81
	<i>March</i>	87		Batchelors	51
	<i>April</i>	109		Maidens	44
	<i>May</i>	100		Children { Boys	234
	<i>June</i>	74		{ Girls	210
	<i>July</i>	90		Women in Childbed	17
	<i>August</i>	86		Infants { Boys	59
	<i>September</i>	77		{ Girls	28
	<i>October</i>	73		{ Still-born { Boys	33
	<i>November</i>	70		{ Girls	28
	<i>December</i>	64		Widows & Widowers	54
	<i>Total</i>	<u>961</u>		<i>Total</i>	<u>961</u>

Married Couple 276.

At Erfurt.

<i>Christened</i>	659
<i>Buried</i>	612
Married Couple	188

At Salfeld.

<i>Christened</i>	119
<i>Buried</i>	90
Married	24 Couple.

At

At Gera.

<i>Buried</i>	Married Men	28	
	Married Women	15	
	Widowers	4	
	Widows	22	
	Batchelors	6	
	Maidens	4	
	Children	{ Boys 76 Girls 42 }	Including 10 Still-born.
	Total	197	
<i>Christened</i>	Boys	153	Including 6 Twins; one of which was Still-born.
	Girls	143	
	Total	296	

Married Couple 82

At Berlin.

<i>Christened</i>	2798
<i>Buried</i>	2492
Married Couple	864

In all the King of Prussia's Dominions.

	Born.	Married Couple.	Buried
In the Kingdom of <i>Prussia</i>	21685	4611	13680
<i>Churmarck Brandenburg</i>	19507	5019	12949
<i>New Marck</i>	7044	1838	4285
Dukedom of <i>Magdeburg</i> } and County of <i>Mansfeld</i> }	8584	2073	6035
Dukedom of <i>Cleves</i> and } County of <i>Marck</i> }	6949	2071	7182
Dutchy of <i>Pomerania</i>	8168	1949	5670
Principality of <i>Halberstadt</i>	2889	781	2326
County of <i>Hohnstein</i>	593	171	399
Principality of <i>Minden</i>	2203	684	2030
County of <i>Ravensberg</i>	2417	680	2166
Principality of <i>Mirs</i>	426	166	529
Dukedom of <i>Geldren</i>	1861	420	1860
County of <i>Teklenburg</i>	497	146	517
County of <i>Lingen</i>	769	255	647
<i>Lauenburg</i> and <i>Butow</i>	607	133	361
<i>French Colonies</i>	711	185	546
Total	<u>84910</u>	<u>21182</u>	<u>61182</u>

Among the Christened were 2215 Bastards. Among the Dead 66, who lived to 90, and upwards as far as 100.

At *Regensburg*, among the Protestants,

Baptized Boys 172

Girls 126

Total 298. Among which were 5 Twins.

Buried Married Men 34

Married Women 46

Including 13 Widows
and four that died
in Child-bed.

Batchelors 13

Maidens 7

Children { Boys 79
Girls 110

Total 289

Married Couple 68

At *Amsterdam*.

Buried 7622

Married 2294

At *Venice*.

Buried 4590

Born 5046

At *Copenhagen*.

Christened Boys 1306

Girls 1183

Total 2489

Buried

<i>Buried</i>	Men	486
	Women	343
	Boys	99
	Girls	93

Total 2751. Being 262 more than were born, and 837 more than there died in this City the Year before; this extraordinary Mortality being ascribed to the Small-Pox being very rife.

Married Couple 748

At Dantzick.

<i>Christened</i>	1999
Married Couple	488
<i>Buried</i>	1872, or 377 more than the Year before.

Bills of Mortality for the Year 1725.

At Breslau.

From Dec. 25 to 31, } 1724.		<i>Among whom</i>	
	30	Married Men	259
January 1725	125	Married Women	153
February	115	Widows and Widowers	158
March	129	Batchelors	64
April	166	Maidens	58
May	122	Children to 10	} Boys 364 Girls 306
June	106	Years of Age	
July	121	Still-born	} Boys 44 Girls 35
August	107		
September	115		1441
October	141		
November	97		
Dec. 1, to 24	67		
Total	1441		

Christened

<i>Christened</i>	Boys	664
	Girls	<u>675</u>
	Total	1339
Married	363	Couple.

At Vienna.

<i>Buried</i>	Men	1007		8	of	90
	Women	1433		1	—	91
	Boys	1865		3	—	92
	Girls	<u>1560</u>		2	—	93
	Total	5865.	Among which	1	—	94
				3	—	95
				2	—	96
				2	—	98
				1	—	99
				3	—	100
<i>Christened</i>		4708		1	—	102
				1	—	103
				1	—	106
				29 of 90 and upwards.		

At Dresden.

<i>Christened</i>	Boys	758
	Girls	714
	Bastards	68
		<u>60</u>
	Total	1600

Buried

<i>Buried</i>	Married Men	225	
	Married Women	174	
	Widowers	36	
	Widows	65	
	Batchelors	99	
	Maidens	167	
	Children	{ Boys 478 } among which, { Boys 53	
		{ Girls 398 } Still-born { Girls 33	
	Total	1642	

Married Couple 519

At Leipsick.

<i>Christened</i>	Boys	478	.
		1	Jew, 20 Years of Age.
	Girls	461	.
	Total	940.	Among which were Posthu-
			mous Births 6
			Twins 12
			Bastards 141, and
			among them 3 Twins.

Married 260 Couple.

<i>Buried</i>	Married Men	113
	Married Women	75
	Batchelors	49
	Maidens	34
	Boys	165
	Girls	106
	Women in Childbed	10
	Children { Boys	58
	{ Girls	51
	Still-born { Boys	45
	{ Girls	24
	Widows and Widowers	77
	Total	<u>807</u>

At Erfurt.

<i>Buried</i>	617
<i>Chriftened</i>	624
<i>Married</i>	183 Couple.

At Coburg.

<i>Chriftened</i>	Boys	105
	Girls	<u>101</u>
	206.	Among which 3 Twins and 8 Bastards.

<i>Buried</i>	Married Men	35
	Married Women	35
	Women in Childbed	2
	Batchelors	4
	Maidens	10
	Children	96. Six of which were Still-born.
	Total	<u>182</u>
	S	<i>According</i>

According to the Months.

	Christenings	Burials		Christenings	Burial
<i>January</i>	17	22	<i>July</i>	12	18
<i>February</i>	27	13	<i>August</i>	10	14
<i>March</i>	24	18	<i>Sept.</i>	21	13
<i>April</i>	18	20	<i>Oct.</i>	23	15
<i>May</i>	16	11	<i>Nov.</i>	11	9
<i>June</i>	15	10	<i>Dec.</i>	12	19
	<u>117</u>	<u>94</u>		<u>89</u>	<u>88</u>
				<u>117</u>	<u>95</u>
			Total	206	183

Married Couple 46

At Regensburg among the Protestants.

<i>Christened</i>	Boys	142	
	Girls	126	
		<u>268.</u>	Among which 4
			Twins.
<i>Buried</i>	Married Men	42	
	Married Women	39	
	Batchelors	13	
	Maidens	11	
	Children	{ Boys 58	
		{ Girls 50	
	Total	<u>213</u>	

Married Couple 80

At *Franckfort* on the *Mayn*.

<i>Christened</i>	Boys	346	
	Girls	385	
		<hr/>	
		731.	Including 10 Twins,
4	Posthumous Births, 1	<i>Jew</i> ,	2 Foundlings, and 22
			Bastards.

Buried 843

Christened at *Sachsenhausen*

Boys 87

Girls 79

166.

Including 2 Twins
and 9 Bastards.

Buried at *Sachsenhausen* 168

Married Pairs at *Franckfort* and *Sachsenhausen* 209.

Marriages at *Amsterdam* in the Reformed Church.

In 1724 2294

1725 2249

At *Venice*.

Born 4836

Buried 4816

At *Dantzick*.

Christened 2012

Buried 1678

Married Couple 46

P. S. The Publisher is informed that this will be the last Account that will be given in so particular a Manner: The University of Breslaw designing for the future to give only a general Table, as practised in London.

III. *Part of a Letter from the Reverend Mr. Benjamin Colman, of Boston in New England, to the late Bishop of Peterborough; giving an Account of the late Earthquake which happened there. Communicated by Dr. Jurin. R. S. S. &c.*

Boston, Sept. 5, 1728.

MY LORD,

YOUR Lordship hopes that some of our accurate Observers took Notes of the Symptoms and Incidents of our late Storms and Earthquake, to communicate to the Royal Society, for the more critical Enquiry into the Causes and Effects of this. How much Mr. *Dudley* or Dr. *Mather*, the Gentlemen here of Learning, who had the Honour to be Fellows of that learned Body, may have done this, I know not. The Earthquake came suddenly upon us in the Night after the Lord's Day, *Octob. 29, 1727*, between ten and eleven, in a very still and fair Evening; the Stars so bright and glittering, that many had taken great Notice of them, and one or two Persons that had been in Places subject to Earthquakes, had said transiently, that if we had been us'd to have 'em, they should expect one. This only general Symptom of its Approach I have heard of, namely, the most serene Sky and calm Air that was ever known, not a Cloud in the Sky, nor scarce a Breath of Wind. And though this is not universally a Symptom when Earthquakes
are

are coming on Places, yet so far as I can inform myself, it has often and for the most Part been observed. It was so in the dreadful Shake at *Jamaica* thirty odd Years ago; and a most ingenious and observing Friend of mine who had his Leg broke on the Point when it sunk, and is still living, tells me, That after that Shock, which was follow'd with many Tremblings and lesser Shakes while his Leg was healing, he could from Day to Day judge by the Face of the Sky and Air, whether there would be any Tremor or Jar of the Earth. If there was any Cloud hanging over the Mountainous Part of the Island, there was no Shake that Day; but if all was serene and fair, he expected one, and it seldom failed. Yet it has not been found so with us, in our After-rumbles and Tremblings, which returned often for some Months after the great Shake, and at Times for nine Months after it.

The Town of *Newbury*, at the Mouth of *Merrimack* River, about forty Miles *North East* from *Boston*, is the Place that seems to have been the Center of the Shock and Shakes felt by us. There the Earth open'd and threw up many Cart-loads of a fine Sand and Ashes, mix'd with some small Remains of Sulphur; but so small, that taking up some of it in my Fingers, and dropping it into a Chafin-dish of bright Coals, in a dark Place, once in three Times the blue Flame of the Sulphur would plainly arise, and give a small Scent, and but a small one. By this it seems evident that it was a sulphurous Blast which burst open the Ground, and threw up the calcin'd bituminous Earth. The Family nearest to this Eruption, it being in that Part of the Town where the Houses lie at a Distance from each other, were in the Terrors

of

of Death; the Roar and Shock being much more terrible upon them than upon others: And yet upon us at forty Miles Distance, and upon others at forty and forty more, it was very terrifying and astonishing.

Five or seven small Shakes were felt by us, after the first and great one, that Night and in the Morning following; but these and other following Rumbles and Tremblings, were louder and greater at *Newbury* and the adjacent Places than with us; and they felt and heard many Times when our Parts did not; but yet from Week to Week, we and the Places about us felt and heard some of the greater Tremors, both by Day and Night.

Upon receiving your Lordship's Letter I have made what Enquiry I could, and have receiv'd
 * Mr. Lowell, from a Reverend Minister in *Newbury* *
 the following Account.

As to any previous Notices of the Approach of the Earthquake, I cannot find any thing to be depended on. The Prognostications that have been among us have all fail'd; such as the Brightness of the Sky beyond what was common; the twinkling of the Stars, and the like. I certainly know that we have heard the Rumbles in all Weathers, cloudy, foggy, rainy, snowy, clear, cold, hot, moderate, windy, calm, &c. indifferently; and at all Hours of Day and Night: (Tho' by the way, we heard these Rumbles oftner in the Night during *Winter*, as I think, and since more usually in the Day) Also when the Wind has been at any Point of the Compass, and at all Times of Tide; and as to the Moon equally when she was nearer or further from her Change or Full: Neither in any particular Weather, nor on any observable Occasion were the Shocks greater, or Rumbles louder. As

As to any Alterations in the Air or Water after a Shock, I could never discern any thing; particularly as to the Wind being raised after a Shock, when it was calm before, which some reported, I could never perceive the least Difference.

One Thing I may add here, very remarkable, and which may be depended on. About the Middle of *April*, that fine Sand which was thrown up in several Places in this Parish at the first great Shock, *Octob. 29*, did actually stink to a very great Degree, even so as to be more nauseous than a putrefying Corpse; yet in a very little while after it did not smell at all. How long it was before it began to stink I am not certain; I know it did not at first, and I believe it was cover'd with Snow till a little while before: There is nothing of Smell now. There has been no Opening of the Ground, throwing up Sand, stopping or breaking out of Springs, &c. as at first. If there had continued any sensible Evacuating of Air or other Matter pent up in the Earth, from the Surface of the Sea or Land adjacent to us, at the Times of our many Rumbles and Tremblings, we should have discern'd it before now. *Newbury* is a Spot of Ground, and so the adjacent Towns, very much inhabited and continually travell'd over; and as to the Sea contiguous to these Parts, it is full of our Coasters by Day and Night; but neither on Land or Water have any sensible Eruptions or Evacuations been observed that I hear of.

P. S. *Boston Weekly News Letter, Sept. 5, 1728.*
We hear from *Newbury* and *Rawley*, That they felt the Shake of the Earth on *Tuesday* last about Four in the Morning; the Noise much like Thunder.

IV. *A Proposition on the Balance, not taken Notice of by Mechanical Writers, explain'd and confirm'd by an Experiment before the Royal Society, by J. T. DESAGULIERS, L. L. D. F. R. S.*

THO' the following Theorem is agreeable to, and deducible from, Mechanical Principles, yet as it has not been taken Notice of by Mechanical Writers, though often talk'd of among Handicraft Workmen, I thought it might not be improper to take Notice of it here, and to make an Experiment agreeable to the Demonstration.

THEOREM, *Figure I.*

A B is a Balance, on which is suppos'd to hang at one End B the Scale E with a Man in it, who is counterpoised by the Weight W hanging at A, the other End of the Balance. I say, that if such a Man, with a Cane or any rigid straight Body, pushes upwards against the Beam any where between the Points C and B (provided he does not push directly against B) he will thereby make himself heavier, or over-poise the Weight W, though the Stop G G hinders the Scale E from being thrust outwards fromwards C towards G G. I say likewise, That if the Scale and Man should hang from D, the Man by pushing upwards against B, or any where between B and D (provided he does not push directly against D) will make himself lighter, or
be

be over-poised by the Weight W , which did before only counterpoise the Weight of his Body and the Scale.

If the common Center of Gravity of the Scale E , and the Man supposed to stand in it be at k , and the Man by thrusting against any Part of the Beam, cause the Scale to move outwards so as to carry the said common Center of Gravity to $k\ x$, then instead of BE , LZ will become the Line of Direction of the compound Weight, whose Action will be encreased in the Ratio of LC to BC . This is what has been explain'd by several Writers of Mechanicks; but no one, that I know of, has consider'd the Case when the Scale is kept from flying out, as here by the Post GG , which keeps it in its Place, as if the Strings of the Scale were become inflexible. Now to explain this Case, let us suppose the Length BD of half of the Brachium BC to be equal to 3 Feet, the Line BE to 4 Feet, the Line ED of 5 Feet to be the Direction in which the Man pushes, DF and FE to be respectively equal and parallel to BE and BD , and the whole or absolute Force with which the Man pushes, equal to (or able to raise) 10 Stone. Let the oblique Force ED ($=$ 10 Stone) be resolv'd into the two EF and EB , (or its Equal FD) whose Directions are at right Angles to each other, and whose respective Quantities (or Intensities) are as 6 and 8, because EF and BE are in that Proportion to each other, and to ED . Now since EF is parallel to $BDC A$, the Beam, it does no way affect the Beam to move it upwards; and therefore there is only the Force represented by FD , or 8 Stone to push the Beam upwards at D . For the same Reason, and because Action and Reaction are equal, the Scale will be push'd down at E with the Force of 8 Stone

also. Now since the Force at E pulls the Beam perpendicularly downwards from the Point B, distant from C the whole Length of the Brachium BD, its Action downwards will not be diminished, but may be express'd by $8 \times \overline{BC}$: Whereas the Action upwards against D will be half lost, by reason of the diminish'd Distance from the Center, and is only to be express'd

by $8 \times \frac{\overline{BC}}{2}$; and when the Action upwards to raise

the Beam is subtracted from the Action downwards to depress it, there will still remain 4 Stone to push down

the Scale; because $8 \times \overline{BC} - 8 \times \frac{\overline{BC}}{2} = 4 \overline{BC}$. Con-

sequently a Weight of 4 Stone must be added at the End A to restore the Æquilibrium. *Therefore a Man, &c. pushing upwards under the Beam between B and D, becomes heavier.* Q. E. D. On the contrary, if the Scale should hang at F from the Point D, only 3 Feet from the Center of Motion C, and a Post *gg* hinders the Scale from being push'd inwards towards C, then if a Man in this Scale F pushes obliquely against B with the oblique Force above-mention'd; the whole Force, for the Reasons before given (in resolving the oblique Force into two others acting in Lines perpendicular to each other) will be reduc'd to 8 Stone, which pushes the Beam directly upwards at B, while the same Force of 8 Stone draws it directly down at D towards E. But as CD is only equal to half of CB, the Force at D compar'd with that at B, loses half its Action, and therefore can only take off the Force of 4 Stone from the Push upwards at B; and consequently the Weight W at A will preponderate,

rate, unless an additional Weight of 4 Stone be hang-
ed at B. *Therefore a Man, &c. pulling upwards*
under the Beam between B and D becomes lighter
Which was also to be demonstrated.

SCHOLIUM I.

Hence knowing the absolute Force of the Man that
pushes upwards, (that is, the whole oblique Force)
the Place of the Point of Trusion D, and the Angle
made by the Direction of the Force with a Perpendi-
cular to the Beam at the same Point, we may have a
general Rule to know what Force is added to the
End of the Beam B in any Inclination of the Direction
of the Force or Place of the Point D.

RULE for the first Case.

First find the perpendicular Force by the following
Analogy, whose Demonstration is known to all that
understand the Application of oblique Forces.

As the Radius:

To the right Sine of the Angle of Inclination ::

So is the oblique Force:

To the perpendicular Force.

Then the perpendicular Force multiplied into the
Length of the Brachium B C, *minus* the said Force
multiplied into the Distance D C, will give the Value
of the additional Force at B, or of the Weight requir'd
to restore the Æquilbirium at A.

Or to express it in the Algebraical Way. Let $o f$
express the oblique Force, $p f$ the Perpendicular Force,
T 2 and

and \propto the Force requir'd, or Value of the additional Weight at A to restore the \mathcal{A} equilibrium.

$$DE : DF :: of : pf$$

$$\overbrace{pf \times BC} - \overbrace{pf \times DC} = \propto$$

The same Rule will serve for the second Case, if the Quantity found be made negative, and the additional Weight suspended at B. Or having found the Value of the Perpendicular Force, the \mathcal{A} equation will stand thus

$$-\overbrace{pf \times BC} + \overbrace{pf \times DC} = -\propto, \text{ and consequently the additional Weight must be hanged at B, because } -\propto \text{ at A is the same as } +\propto \text{ at B.}$$

SCHOLIUM II.

Hence it follows also, that if, in the first Case, the Point of Trusion be taken at C, the Force at B, (or Force whose Value is requir'd) will be the whole Perpendicular Force; because CD is equal to nothing: And if the Point D be taken beyond C towards A; the Perpendicular Force pushing upwards at that Point, multiplied into DC, must be added to the same Force multiplied into BC, that is $\overbrace{pf \times BC} + \overbrace{pf \times DC} = \propto$.

The Machine I made use of to prove this experimentally, was as follows. Fig. 2. The Brass Balance AB is 12 Inches long, moveable upon the Center C, with a Perpendicular Piece Bb hanging at the End B, and moveable about a Pin at B, and stopp'd at its lower End b (by the upright Plate GG) from being thrust out of the Perpendicular by the pushing Pipe FE, whose lower Point being put into a little Hole at H, the upper Wire or Point (when put into another little Hole under the Beam at D) is by Means of the

Worm-spring E F pressing against the Plug E to drive forwards the said Wire *b* D, made to push the said Beam upwards with the Force of the Spring. TSS is a Stand, to which is fix'd the Pillar TC that sustains the Balance; and it has also a Slit SS to receive a Shank of the moveable Plate GG, to be fix'd in any Part of the Slit by a Screw underneath.

EXPERIMENT.

Hang on B *b*, as in the Figure. Then let EF be so applied to the Hole H, that its upper Wire *b* D *k* may go through a little Loop at D so as not to thrust the Beam upwards, but be in the same Position as if it did, that by hanging on the Weight W, the Brachium BC with B *b* and FE may be counterpois'd; and then the Action against D and H may be estimated without the Weight of the pushing Pipe.

Then drawing down the End of the Wire *k*, thrust it into the little Hole under D, and B will be so pull'd downwards as to require the additional Weight of 4 Ounces to be hung on at A to restore the *Æquilibrium*, when BH is 4 Inches, BD 3 Inches, and the whole Force of the Spring equal to 10 Ounces.

I need not here say, that for explaining the second Case, B *b* is to be suspended at D, with the Plate GG fix'd to stop it at the Place M to keep it from being push'd towards T, and that the upper End of GFED *k* must push into an Hole made under B, in which Case the Weight P must be hang'd at B to restore the *Æquilibrium*.

P. S. To shew experimentally that the Force which the Spring exerts in this oblique Trusion is equal to 10 Ounces: Take the Beam *A B*, which weighs 4 Ounces, from its Pedestal *C T*, and having suspended at each End, *A* and *B* 3 Ounces, support it under its Center of Gravity by the pushing Pipe *E F* set upright under it, and you will find that the Beam with the two Weights will thrust in the Wire *k b* as far as *b*, the Place which the oblique Trusion drives it to.

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *July, August, and September, 1729.*

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- II. *A remarkable Conformation of the Urinary Parts, communicated in a Letter to the Same, by Mr. John Budgen.*
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VI. *An Account of a Book entituled, Helperi & Phosphori Nova Phænomena, &c. Auctore Francisco Blanchino; by John Hadley, Esq: R. S. V. Pres.*

VII. *Observations on a Treatise wrote by Mons. Helvetius of Paris, designed to prove that the Lungs do not divide and expand the Blood, but that on the contrary, they cool and condense it. By F. Nicholls, M. B. Præl. Anat. Oxon & F. R. S.*

VIII. *Observationes diversæ Lunaris Deliquii die 2 Februarii, A. D. 1728-9.*

IX. *Observationes quædam Eclipsæ Lunaris Die 29 Julii habitæ, A. D. 1729.*

- I. *A Letter to Sir Hans Sloane, Bart. R.S.Pr.&c. containing a Description of some uncommon Appearances observed in an Aurora Borealis, by the Reverend Mr. Derham, Canon of Windsor, and F. R. S.*

Honoured SIR,

THE *Lumen Boreale* is of late so common a *Phænomenon*, that I should not think it worth troubling you with that of *Sunday Oct. 13* last, but that I observed some very different Appearances of it at *Redbridge in Hants*, near *Southampton*, where I then was on our College Business.

About 8 in the Evening of that Day, my Family and others at *Windsor*, saw a considerable *Streaming* in the *North*, with such bright Lances and Columns as usual. But at *Redbridge* none such appeared, only in the *North*, I observed a great thick, black Bank of Vapours; the Top reaching about 20° above the Horizon, without any Convexity or Curvature, as is usual in most of the *Streamings* I have seen; but instead of that, the upper Part was indented in many Parts, with long black Pyramids, somewhat resembling the Streams of the *Lumen boreale*, the Edges of which were gilded with lucid Rays, of the Streaming Colour: And all over the Clouds, or Vaporous Bank, I discovered a great Commotion or Disturbance behind them, as if something was rolling, or tumbling behind them. The End of all these Appearances I

U

expected

expected would have been *Streaming*: But in less than an Hour, the Clouds (which had been pretty still) began to move to the *S. W.* and at last obscured the whole Hemisphere; which before was all clear enough (except towards the *North*) to shew the Stars, although bespread with Vapours, like a thin Fog, a little inclining to red.

This Relation I thought it convenient to give you, and the Illustrious Society, because it may assist such as are wiser than my self to discover the Nature of this difficult *Phænomenon*.

Your much obliged

Humble Servant,

W. DERHAM.

II. *A remarkable Conformation of the Urinary Parts, communicated in a Letter to the Same, by Mr. John Budgen.*

I Am advised to communicate to you a very uncommon Case, which I met with in my Country Practice, and is as follows.

In *Villâ Com' Surria*, *Ockley* vulgò dictâ, anno 1711 nata est Infantula, cujus in Tergo, circa vertebra inferiores, apparuit Tumor indolens, cutis coloris

rem.

rem, Oviq; columbini majusculi magnitudinem referens, qui cum Puellâ tantoperè concrevit, ut circiter nonum, vel decimum ætatis annum, ubi primùm conspexi, Vesicam vitulinam, aëre distentam, sed sine Cervice, planè repræsentaverit. Anno præsentis (*viz.* 1728.) Vesicæ bubulinæ magnitudinem æquabat. Die 29 Jan. proxime elapso in Lecto jacenti disruptus est hic Tumor, a quo multum Liquoris, instar Urinæ profluebat. Re perspectâ, invenimus Tunicas (& interiùs Materiam mucosam) Ureteres, Venas, & Arterias, tales omninò, quales Vesica habere consuevit: nec defuit commercium quoddam cum Partibus internis per foramen in vertebriis Digitum hominis minorem in Abdomen admittens, quod Vasa memorata recipiebat. 2^o Die Feb. 1728, horam circiter decimam nocturnam obiit Puella; & si Cadaver aperire per Parentes, huic Rei strenuè reclamantes, licuisset, credor quidè in Abdomine, Vesicæ Cervicem, & nullam aliam Vesicam inveniremus; non enim post ruptum Tumorem vel semel minxerat.

Dat. 3^o Die Feb. 1728.

I hope you'll be pleased to take this in good Part,
from,

*Darling, Ap. 18,
in Surry, 1729.*

S I R, your very

humble Servant,

JOHN BUDGEN.

III. *An Observation of the Eclipse of the Moon, by Arthur Dobs, Esq; at Castle-Dobbs near Carrickfergus in Ireland, Feb. the 2d, 1728-9; communicated by Oliver St. John, Esq; F.R.S.*

Castle-Dobbs, Feb. the 8th, 1728-9.

Dear S I R,

HAVING had a fine Observation of the Eclipse of the Moon which happened last *Sunday* Evening, I have sent you it to communicate to the *Royal Society*, to ascertain our Longitude here, and in other Places where it was observed.

The Observation was made by a nine Foot Glas. Having adjusted a monthly Pendulum Clock by a Meridian Line on the 30th of *Jan.* and further corrected by the Meridian, *Feb.* the 6th 1728-9.

Hours apparent Time.

	h	'	"	
p. m.	6	27	0	- - Penumbra observed.
		29	30	- - Moon's Limb immersed.
		33	0	- - { Eastern Limit of Palus
				- - { Marcotis immersed.
		35	50	- - Mons Climan. immersed.
		42	40	- - Mons Porphyrites immersed.
		50	0	- - Infula Melis immersed.
		52	40	- - Mons Ætna immersed.
		54	20	- - Inf. Sardinia immersed.
		56	20	- - Inf. Rhodes immersed.
		58	0	- - Inf. Corfica immersed.
				h7 - 0'

Hours apparent Time.

h ' "

p. 10.	7	-	0	-	30	-	-	{	Mons Sinai's, Eastern Limit
								}	immersed.
	2	-	0	-	-	-	-	{	Mons Sinai totally immersed.
	6	-	50	-	-	-	-	{	Inf. Besbicus, Eastern Limit
								}	immersed.
	11	-	50	-	-	-	-	{	Mons Herminius immersed.
	13	-	50	-	-	-	-	{	Promontory Archeroulia im.
	22	-	0	-	-	-	-	{	Mare Caspium, Eastern Limit
								}	immersed.
	24	-	20	-	-	-	-	{	Palus Mæotis, Eastern Limit
								}	immersed.
	27	-	30	-	-	-	-	{	Palus Mæotis, totally immerg.
	30	-	15	-	-	-	-	{	Moon totally immersed.
	9	-	8	-	30	-	-	{	Moon's Eastern Limb emer-
								}	ged near Mons Acabe.
	13	-	0	-	-	-	-	{	Palus Mareotis emerged.
	15	-	0	-	-	-	-	{	Mons Climan. emerged.
	23	-	30	-	-	-	-	{	Mons Porphyrites emerged.
	29	-	10	-	-	-	-	{	Mons Sinai emerged.
	33	-	30	-	-	-	-	{	Mons Ætna emerged.
	49	-	0	-	-	-	-	{	Inf. Besbicus emerged.
	10	-	1	-	0	-	-	{	Mare Caspium, Eastern Limit
								}	emerged.
	5	-	0	-	-	-	-	{	Palus Mæotis emerged.
	10	-	0	-	-	-	-	{	A Penumbra observed, the
								}	Moon's Limb emerging.
	11	-	0	-	-	-	-	{	The Limb evidently emerged.

From the Beginning to the End of the Eclipse 3^h 44'Totally Eclipsed — 1^h 38' 15"

IV. *De Frigida in Febribus Usu. Auctore Cl. Nicolao Cyrillo Prim. Med. Prof. Neapol. & R. S. S.*

USUS Frigidæ & Frigidorum in Febribus haud recens est, sed apud Antiquissimos Medicos minimè infrequens fuit. In Febribus enim calidioribus, post Paroxyfmi ἀκμὴν, liberaliorem Aquæ, vel cuiuspiam refrigerantis liquoris potationem concedebant, quâ defervescente febrili æstu, Æger placidè conquiescens in criticum sæpenuerò sudorem exsolveretur. Verùm Febres curare *sola nivat à Aquâ* copiosissimè per plures dies exhibitâ, omni subtracto medicamento alienoquoque, id quidem omninò novum existimo; atque non solum insolenter, sed, ut verum fatear, audacter nimis, non multis ab hinc annis hîc tentatum, methodo, ut rumor fuit, ab Hispaniâ, rudi & indigesto Commentariolo communicatâ: quâ curandi ratione nonnullos ex ipsis Orci faucibus, præter omnem expectationem, ereptos sub oculis nostris attoniti vidimus. Hæserè primùm cauti Medici tantâ Aquæ alluvie perterriti: at frequenti felicissimoque eventu excitati, tentandi primùm, mox audaciores facti, quod quid in cæco impetu, & nullo morbi, morbiq; temporum discrimine aggrediebantur, ad cautiorem & securiorem methodum rede gere: ita ut nullus jam apud nos sit Medicus, qui Cleophrantus δοσιψυχρὸς (ut notat Harduinus in Plinium, Lib. 26.) appellari nolit. Hujus Methodi Canones repetitis experimentis confirmatos exponam. Magnum enim remedium est Dieta Aquea, (hoc nomen appellare libuit) quare in illius administratione,

quem.

quemadmodum in omnium magnorum remediorum usu, accuratissimis cautionibus procedendum, ne quod pro Aegrotantis salute instituitur, illius potius necer molitur.

Præcipuus Canon est, ut post aliquot horarum à cibo abstinentiam, Ventriculo scilicet omninò vacuo, Aqua nive refrigerata ebibi incipiat, ad libram unam vel duas, pro Aegrotantis ætate, viribus, aut etiam siti. Eadem copia singulis horis, aut secundâ quâque, ut tardius, repetenda, eademque noctu diuque, nullâ factâ intermissione nisi per subrepentem fortassè somnum, exhibeatur. A Cibo omninò abstinere debent Aegrotantes: Experientiâ enim constat, illum cum Aquâ copiosâ permixtum, non solum in Ventriculo putredinem concipere, verum etiam ab eodem epotæ Aquæ substantiam intici, eamque minùs aptam reddi, quæ facilè exilissima vascula permeare, adeoque in extima simul & intima corporis dijici ac diffundi possit, ad præcipationem & secretionem noxiorum humorum molicendam. Inedia hæc ad plures dies producenda, quousque scilicet Febris vel prorsus intermiserit, vel ad summam remissionem devenierit, atque Aeger identidem de fame conqueri incipiat: si enim maturius exhibeatur Cibus, statim Febris suis stipata Symptomatibus iterum recrudescet. Quapropter nonnunquam ad septem, imò ad decem & plures dies (dummodò ab Aquâ non abstineatur) Aegrotantes ab omni alimento prohibemus. Neque ab hac abstinentiâ quidquam metuendum: vel quòd ob Aquæ frigiditatem, arctioribus redditis cutis spiraculis, Transpiratio insensibilis, adeoque nutritionis necessitas imminuatur; vel quòd Aqua ipsa Nutrimenti Officinas assiduè

assiduo præterfluens, si quæ inibi sunt alimentorum reliquæ (sunt autem semper impactæ) eas secum rapiat, atque per universum Corpus diffundens, nutritionis negotio, quoad fieri potest, consulat. Quomodocumque autem se res habeat, illud quotidianâ praxi confirmatum est, Cibus cum copiosâ Aquâ commisceri, absque summo Ægri periculo, non posse: ita ut quamprimum Cibus Ægrotanti conceditur, ille vel absque Potu, vel cum exiguâ Aquæ potatione exhibendus: imò concedendum quoque est aliquot horarum intervallum à Frigidæ potu vacuum, quo commodè Cibus in Ventriculo digeri queat.

Hic seligendus tenuissimus & ὑπερῖος, ut Panis purâ Aquâ coctus, Pastilli de micâ Panis, Ovum forbile, vel vix ferculum aliquod jurulentum. Hæc semel primum & paucissima, hinc bis in die exhibenda, ut sensim ad lautiusculum prandium, servatâ tamen exiguâ cœnâ, gradum faciamus: omninò verò, etiam per mensem & ultrâ, carnibus parcendum. Cum hujus generis Cibo vescuntur Ægri, haud Aquæ valedicendum, sed peractâ illius assumti digestionē, ad duas vel tres potationes erunt cogendi: quousque integrè devicto morbo, corporis vires sensim recuperantes, ad diu exoptatam convalescentiam perducantur.

In hujus autem Curationis curriculo quadam accuratè animadvertenda sunt. Principem locum tenet Observatio, num Aqua assumpta facilem sibi transitum paret, an non. Cum Urinæ, saltem post dici interval- lum, copiosiores & decolores sensim fieri incipiunt; tunc Aquam viam sibi facere cepisse puta. Nonnunquam primâ statim die vel secundâ tertiâve, Alvus
1 solvitur,

solvitur, cum ejectione primùm fæculentioris saburræ, mox variegatorum humorum : hinc spes major affulget ; Febris enim, Alvo solutâ, sensim se remitti, atque symptomata sedâri incipiunt. Quod adeò verum est, ut si secundus vel tertius dies excurrat, absque eo quod ventre secedant Ægri, etiamsi universa fortè Aquæ quantitas per Urinæ vias foras amandetur ; Clysteribus tamen suppositis, & Oleo Amygdalarum dulcium per os assumpto, lubrici reddendi : crassiores enim humores, qui in primis viis continentur, quique Febrim fovēt, vel in Febricitantium corporibus ex Morbo produci solent, haud possunt per cæca Urinæ secernicula foras protrudi, sed per amplos Intestinarum tubos sunt eliminandi. Adde, quòd exantlatis primis ductibus, facilè poterit Aqua in ultimos Corporis recessus trajici, atque Sanguini, aliisque secundariis dictis liquoribus medicinam facere.

Si verò accadat (accidit autem sæpè) ut Parotides appareant, vel cum ipsis Alvi vel Urinæ excrementis purulentum quid intermixtum observetur, quod evidens indicium est maturi & rupti jam Abscessûs ; haud ab Aquæ exhibitione surperfedendum, sed eâdem urgendum magis est. Una enim Aqua, quæ stagnantes in internis partibus humores ad externas depellere, collectos ad maturationem perducere potuit, vim quoque habebit eisdem per varia Corporis secernicula integrè deturbandi, atque partes Abscessu prehasas à *necrofi* præservandi : quemadmodum sæpissimè in Praxi vidimus. Praxis tamen eadem nos docuit, abscessus in Cerebro & Thorace factos non adeò facilè Aquæ usu superatos esse : etsi non paucos vidimus, Pure è naribus, auribus, ore, & tussi quoque è pulmonibus educto,

X

integrè

integrè sanatos. Solemus proinde cùm talium symptomatum signa superveniunt, haud Aquæ præsidium respicere; sed si somnolenti evadunt Ægri, Vesicantia, vel aliud Phlegmaturum genus applicare: aut si difficultate spirandi exerceantur, Oleum ex Amygdalis dulcibus recens expressum propinare, vel Aquam ipsam ex frigida tepidiusculum reddere. Non rarò insuper accidit, ut primis præsertim Aquæ dietæ diebus, vomitus, & quidem vehemens, superveniat: quo si heterogenei humores, ut fieri solet, ejiciantur, pro bono habendum; cessat enim cum Ægrotantis levamine, postquam venter omninò exoneratus sit. Quòd si Aqua ipsa vix epota evomatur, ad iteratas & frequentiores potationes Æger cogendus: etenim Aquam vomitu rejectam maligni humores subsequi solent. Constantè item & assiduo Aqua est exhibenda, si Singultus suboriat: hunc enim quemadmodum ab Aquâ excitatum, ita ab Aquâ continentur epotâ compesci observamus. Sudor verò si Frigidam potanti superveniat, solet vires exsolvere, non sine magno vitæ discrimine: Id quidem paradoxon videri poterit iis, qui ex Frigidæ in Febribus potu sudorem expectant, in quo *magnum* domini *Hancock Febrisfugum* consistere scimus. At in diætæ Aquæ usu, si sudor superveniat, is cohibendus, Aquâ adhuc frigidiori & copiosiori exhibitâ, Ægrique corpus remotis stragulis, ventilabro, & perflatu conclavis refrigerandum: sunt qui & nive ipsâ contritâ conspergere audent.

Maxima porrò in Aquæ usu Medicorum crux est, cùm Ægri vel delirio, vel Lethargo, vel summa virium abjectione affecti, ad Aquam justâ copiâ & frequentiâ bibendam impares redduntur. Tunc quidem
 omnis

omnis adhibenda est industria, ut postremum quod illis restat remedium, nempe Aqua, exhibeatur: Quod à delirantibus vi & minis, à valdè debilibus & consopitis Nive in os intrusâ, per fas & nefas, nonnunquam extorsimus.

Post expositam Aquæ diætæ methodum, & quomodò symptomatibus ἐπιφαυνόμεναις occurrendum sit, reliquum est, ut quibus in Febribus, & quo illarum tempore ad hoc præsidium deveniendum sit, exponamus. In principio sanè Universali Febrium haud opportunum est statim Aquam arripere: quum enim tunc temporis cruda & crassa sint omnia, haud jure speres à copiosâ Aquâ peccantes humores posse vel secerni vel exturbari. Secùs in Morbi statu cum omnia exacerbata sunt, & ἡ νόσος ἀνθήει, ut ait *Hippocrates* cum nempe Ager ad maximum periculum perductus est, Aquæ præsidium opportunum locum habet: tunc enim materia Febrim fovens ex diutinâ ebullitione, particularum contritionem quandam, vel, si mavis, aliqualem coctionis umbram adepta, poterit copiosæ Aquæ exhibitione, illiusque cum humoribus corporis permissione veluti præcipitari, secerni, atque quâ data porta evacuari. Hinc igitur sæpe accidisse vidimus, ut fortunatiùs evaserint, qui in ipso veluti mortis agone constituti ad hoc extremum præsidium, tanquam ad sacram anchoram confugère. Hoc monitum negligentes audaculi quidam Medici, Aquam in Febrium principio, vel incremento exhibentes, in maxima pericula, & mortem ipsam, Ægros deduxere. Non inficias tamen iverim, in Febribus Biliosis, seu tenues humores pro causâ agnoscentibus, non infelici ausu, Aquam quandoque in ipso principio exhibitam esse: & ratio ex suprâ dictis evidentissima est.

In Febribus igitur Acutis, Malignis, & lethali bus omnis generis, quo tempore opportunum videbitur, quod à maximo Ægri periculo significare solet, ad diætam Aqueam deveniendum. Nam vel Febres tales sunt, ex quibus ad concretionem tendit sanguis; & tunc Aquâ copiosâ cum eo permistâ facilè poterit fluidam naturam ferè amissam iterum recuperare: Vel ex Febre sanguinis massa ad nimiam tenuitatem, cum spirituum exsolutione vergit; atque hoc casu Aqua, præsertim frigida, salia acria sanguinem dissolventia solvere & retundere potis erit. Unde phœnomeno lux, cur scilicet frigidum jam redditum Febricitantis Corpus ex frigidæ potatione veluti miraculo incalescat. Sive enim sanguis ex pernicioso spirituum effluxu con crescere incipiat, sive ex nimia illius dissolutione spiritus evolent; semper frigidæ copia cum illo permista (accedente quoque pororum cutis constrictione) æque spirituum dissipationem prohibebit, adeoque Calor amissus revocabitur.

Hinc illud hic inculcandum, quod à principio insinuavimus, Aquam non nisi nivatam Febricitantibus præscribendam: primùm enim frigidâ se eâ copiâ ingurgitant Ægri, quæ operi necessaria est, calidam verò respuere post primas potationes solent: præterea ab Aquæ frigiditate Ventriculi Fibris vis major elastica accedit, quâ propelli in ultiores vias usque ad sanguinem ea facilè possit; contrà tepescens fibras easdem ad toniam disponens, sui mole ventriculum inflat, pondere premit ac anxium reddit.

Haud tamen dissimulabimus, nos quandoque non frigidam, sed calentem Aquam præscribere: cum scilicet Pulmonum & Viscerum Inflammationes & dolores cum Febribus copulantur: veriti ne frigidum
partes

partes phlogosi prehenſas ad *νεκρωσιν* diſponat. Verùm negare minimè poſſumus in his caſibus nonnunquam ad frigiduſculam, etſi non nivatam, tranſitum fieri : cùm nempe, repentis Aquæ faſtidio affecti Ægrotantes, illam aſſiduò bibere renuunt. Satiùs enim eſſe reputamus, multam frigiduſculam, quàm paucam tepentem, ſed operi imparem miniſtrare.

Juxtà hos canones (quos Experimenta ſæpiùs inſtituta, & Ratio poſtmodùm, ſi non inviſta, ſaltem non omninò infirma ſuaſit) Diætâ Aqueâ in Febribus multoties uſi, felices eventus notavimus, ut *ἀρίστην μὲν ὕδωρ* verè fateremur. Nonnunquam tamen præconceptâ ſpe frustrati ſumus, quod à Medicinæ fortunâ, præſertim in magnorum Medicamentorum adminiſtratione, non abhorret : nil enim adeò certum in illâ eſt, quod fallere etiam accuratiſſimos Præcticos ſæpè non poſſit.

Hucusque de Frigidæ uſu in Febribus locuti ſumus : verumtamen ſunt & alii Morbi, in quibus Aqueam diætâ, & non ſine Ægrorum emolumento, analogiſmo quodam ducti tentavimus. Tales ſunt Diarrhœa, Dyſenteria, imò & Coeliaca, & Lienterica affectio : tales ſunt Iſchuria Renalis & Dyſuria : tales Cardialgia & Cholera Morbus, Hypochondriaca & Hyſterica affectio : nec caremus exemplis Hydropiſ (quis credat ?) copioſâ Aquâ epotâ curati : reſeratis nempe cœcis Renum & Alvi viis è quibus & Aqua & ſerofus latex ubertim effluxit. Imò & ſalutarem Aquæ Diætæ uſum experti ſumus in Variolis, ſed in tertio illarum ſtadio, ad necem Ægris tendentibus, ex Abſceſſibus in cerebro & Pectore formatiſ : quo remedio
ingentem

ingentem puris copiam è naribus & ore excerni vidimus. Haud tamen in omnibus his Morbis Aquæam Diætam, hoc est, Aquam solam, omni interdicto Cibo, adhibemus ; sed in Chronicis largâ frigidæ potatione quatuor horis ante parcum prandium, atque alterâ octo horis à prandio, contenti esse solemus.

Hæc quidem sufficere putavi ad meum propositum : unum tamen postremò animadvertendum apprimè esse duco, quoad Aquæ frigidæ exhibendæ copiam ; gravius scilicet delinqui, si minori quantitate propinetur, quàm si excedenti. Quum enim eo fine Febricitantibus in valde angipiti statu constitutis Aqua exhibeatur, ut in omne Corpus diffusa, meatus referet, liquoribus motum & tenuitatem naturalem impertiatur, ac membrorum omnium calorem roburque foveat ; id præstituros nos frustra pollicebimur, modicam proxinantes Aquæ quantitatem, quæ in Ventriculo & primis Visceribus moram trahens, tantum abest ut possit ulteriùs progredi, ut potiùs cum noxiis humoribus ibi stagnantibus permista, illorum putrefactionem promoveat, Ægroque perniciem molliatur. Opus igitur est, ut maximâ quantitate & successivè ingeratur, ad hoc ut copiâ viam sibi paret, & veluti alluvie Corpus universum inundet. Id autem eò audentiùs prosequendum, si post primam transactam diem, transitûs Aquæ signa per Urinam vel alvum apparuerint. Eò enim Aquam reliquis Remediis securitate præstare putamus, quòd tamen nonnulla Medicamenta possent fortassè maximos Morbos debellare si excedenti dosi exhiberentur, veluti stibium Diaphoreticum, Bezoarticum, & sal volatile quodcumque

quodcumque, & ipsum Vinum generosum copiosè epotum; verumtamen quis non videt, ex ipsâ excedenti dosi maximum vitæ periculum, debilibus præsertim Ægrotantibus, imminere? sola Aqua innocentissima & tutissima videtur: vix enim Æger est adeò viribus destitutus, qui uberrimam Aquæ copiam sustinere non valeat. Hinc haud παρὰ μέτρον factum puto, si etiam cùm desperata res est, & jam conclamatum, Medicus facto prognostico, & expositâ quidlibet audendi occasione, Aqueam Diætam, etsi contraindicatum remedium, si non præcipiat, saltem permittat: nonnunquam enim improvisis Naturæ Modis, desperatos jam Ægros ex insperato ad salutem rediisse vidimus: ut pro sano consilio illud habendum sit, satius esse anceps remedium experiri, quàm nullum.

Hæc sunt quæ apud nostrates de Aquæ in Morbis usu experiri usu venit, quo nullum familiarius per vulgi ora nunc fertur Ægri tudinum omnium remedium: ut nostris his temporibus aptari commodè possit Versiculus, quem de *Euripide* à ventris cruciatibus, ope Clysteris maris Aquà parati, liberato, refert *Laërtius*:

Ἡ θαλάσσα κλύσθ' πάντα τῶν ἀνθρώπων κακὰ

An simile accidere possit in frigidioribus Regionibus (de quo haud desperem, nam etiam hybernâ tempestate tales per Frigidam Curationes hîc feliciter prosequimur) videant accuratissimi Viri, qui in Boreis Terræ plagis, non sine maximâ laude & fortunâ faciunt Medicinam. Neapoli Calendis Januariis, Anno 1729. St. V.

NICOLAUS CYRILLUS in Reg. Univ. Neap.
Prim. Med. Prof. & Reg. Soc. Leg. Socius.

V. A

V. *A short Account of the different Kinds of Ipecacuanha*, by Dr. Douglass, Med. Regin. Extr.
& R. S. S.

I beg Leave to take up a small Part of this honourable Society's Time, in laying before them some Specimens of that celebrated vomiting Root, whether truly, or falsely called *Ipecacuanha*, which I keep in my Collection of the *Materia Medica* ; together with a few Observations concerning their outward Appearance, by the Help of which the several Kinds thereof may be distinguished from one another ; and an Account of what I have hitherto been able to learn concerning the true Places of their Growth.

The first general Division of these Roots must be, as has been already hinted, into true and false ; and each of these may be again subdivided into several Species, the distinctive Note of which is principally taken from their Colour.

Of the true *Ipecacuanha* I have four Kinds, Black, Brown, Grey, and White ; but I cannot pretend to determine whether they belong to different Plants, or are only Varieties of the same Plant owing to the Soil in which they grow, as is affirmed by our worthy and learned President Sir *Hans Sloane* Baronet. And as these Roots are never imported to us entire, it is impossible to give any certain Description of them in that State.

However, by comparing the several dried Pieces as we have them, we may very probably conjecture
that

that a short radical Trunk descends from a *Caulis*, and is afterwards divided into several large Branches, and these again into smaller ones, in different Series, with minute Filaments or Fibrillæ going out from them.

Each Piece is made up of two general Parts, an Outer or Cortical, and an Inner or Fibrous, which like a white Nerve, or smooth compact Fasciculus of woody Filaments, runs through the Center or Axis of the Roots, and perhaps encloses within it a small Medulla or Pith, which however is hardly discernable by the naked Eye.

The Cortical Part is corrugated by two Sorts of Wrinkles, one superficial, consisting either in circular Rings or little Knots which do not go quite round; the other penetrating into its Substance, being deep Incisures or Fissures reaching all the Way to the Nerve.

What Lengths these Roots are of when taken out of the Ground, cannot be determined: I have met with some Pieces above nine Inches, many above six, but the greatest Number are still shorter.

We find them bent, wreathed, and contorted into all Manner of Figures; and indeed few Pieces are altogether straight for any considerable Length.

What has been hitherto said, agrees to all the true *Ipëcacuanha-roots*; but several other Things are still to be taken Notice of, in which they differ.

The Black Sort is the smallest of the four, very hard, and the Fissures wide and numerous. The outward Colour of the Cortex is not equally black in all the Pieces of this Kind, and its inner Substance, as well as the Nerve, is mostly white, tho' not always in the same Degrees.

The Brown Sort is larger than the Black, the Fissures at larger Distances, the inner Substance of the Cortex darker, and the external Colour has several Degrees of Redness in the several Pieces.

The Third or Grey Sort is sometimes found of a darker, sometimes of a lighter Colour, and the Inner Substance of the Cortex is Brown streaked with White. It is much larger than the black Sort, many Pieces being above a quarter of an Inch in Diameter, but the Nerve is smaller in Proportion to the cortical Part. I have met with few Pieces of this Species above five Inches in Length; but, as I already observed, nothing can be concluded from thence as to the Length of the whole Roots.

The Fissures are here still fewer than in the brown Sort, and in some Pieces scarce any are to be met with. The superficial Corrugations are various in different Roots, some being almost wholly smooth, and in others the Wrinkles rather longitudinal than circular.

The white Kind, as far as I can judge by the small Sample which I have of it, is of very different Sizes, some Pieces of it being larger than any of the grey Sort, and the rest much less. The whitish Colour of the Cortex is mixed with a yellowish Cast, and the nervous Part is very large in Proportion to the rest. Very few Fissures are to be observed therein, and hardly any reach so deep as the Nerve. The other Corrugations are likewise very shallow, and most of them longitudinal; but it seems to be more knotty than the other Kinds, and these Knots I take to be owing chiefly to the *Fibrillæ* which go out from the larger Branches of the Roots.

The

The *Loci Natales*, or true Places of Growth of these different Species of *Ipecacuanha* have not as yet been fully settled.

The Black Sort is hitherto known to come only from *Brasile*, whence we get it by the Way of *Lisbon*, and some of our Druggists for that Reason distinguish it by the Name of the *Brasile* Root.

About the Brown Sort, I am informed by Dr. *James Houston*, who resided for several Years in *New-spain*, that it grows plentifully at some Distance from the City of *Cartagena* in the Kingdom of *New Granada*; from whence it is frequently sent in Sa-rooms or Skins, containing 100 Weight, to *Jamaica*, and so to *England*; where it is certain we have had it of late Years in great Abundance.

The Grey *Ipecacuanha* is with us preferred to all the rest, and by far the most generally used when it can be had. It is said by Authors to grow in *Peru*, from whence we get it by the Way of *Spain*, it being brought from *Peru* to *Porto-Bello*, and from thence into *Europe*, by the *Spanish* Galleons. Some Parcels thereof are likewise probably sent from *Porto-Bello* to *Jamaica*; for we are certain that it has sometimes been imported hither from that Island. By some Specimens that were brought me by Mr. *Lightbody*, an ingenious Surgeon, from *St. Thomé*, a *Portuguese* Island under the Equinoctial, whither they were sent directly from *Brasile*, it is evident that this Species is likewise a Native of that Country, and therefore must either have been included by *Piso* under one of the two Species mentioned by him, or else discovered since his Time. According to Father *La Bat*, in his late

Voyage to the Islands of *America*, this Species grows also plentifully in *Martinico*, where for many Years past it has been used by the Inhabitants.

The White Sort, called by the *Portuguese*, *Ipecacuanha Blanca*, is said by *Piso* to grow in *Brasile*, and if we may believe *Father La Bat*, it is likewise found in *Martinico*.

These are the four Kinds of true *Ipecacuanha* which have hitherto come to my Knowledge; but I have met with two other Roots to which that Name has been falsely ascribed, which from their outward Colour I shall call White and Reddish Brown.

The White Sort agrees pretty much both in Colour and Surface with the true White, but it is not near so knotty. It is likewise considerably larger in Size, straighter and softer to the Touch.

The Brown Sort is of a deeper Colour than the true Brown, and many Pieces thereof have some Mixture of Red (from whence it has been sometimes called Red *Ipecacuanha*) and the inner Substance of the Cortex enclines to a reddish Yellow. The Pieces thereof are much longer than any of the former Sorts, some of them measuring sixteen Inches, and they are of a Size between the Black and Grey. The Fissures are at greater Distances from one another than in the true Brown, and the Spaces between them much smoother. In a Word, though this Root when mixed with the true Brown, to which it bears the greatest Resemblance, may easily be confounded therewith; yet when they are attentively compared, their whole Appearance sufficiently distinguishes them.

Both these false Kinds were brought me from *Maryland* in 1725, by one M. *Seymour* a Surgeon, who informed me that they grow there in great Plenty, being called *Ipecacuanba* by the Inhabitants, and used as a Vomit by those of inferior Rank. I have since that Time received a Sample of the Brown Sort, taken from a Parcel which lay in the Custom-house, above twelve Years ago, and called by the Name of wild *Ipecacuanba*.

The forementioned Illustrious Sir *Hans Sloane* did me the Honour to inform me that this false Brown Kind was the same that was formerly sent to him from *Virginia* for the true *Ipecacuanba*, and which he afterwards discovered to be the Root of a poisonous Apocynum described by him in his *Natural History of Jamaica*; in which Island it is very common, and likewise in *New-spain*, as appeared to him by the Specimens sent him by his Correspondent Dr. *Burnet*.

In his Introduction to the second Volume of that excellent History, he has obliged us with a very full and distinct Account of what he had learned from his Friends abroad, concerning the pernicious Effects of the several Parts of this Plant, and of the great Pains he was at to prevent its being brought into Use in this Country, which was then very much to be apprehended. *Helvetius's* Name will always be mentioned with Honour for the great Share he had in rendering the Use of the true *Ipecacuanba* common in *Europe*; and I cannot think that Sir *Hans Sloane* deserves a much less Degree of Praise for having detected this false Kind, which was insensibly creeping into Use,

the Effects whereof might otherwise have proved as fatal as the other is found to be beneficial.

I have only to add, that this poisonous Kind of Apocynum is now cultivated by several curious Persons about *London*, and that I design with all convenient Speed to present this Society with a particular Description thereof, taken from a Plant which I had last Summer growing in my own Garden.

VI. *An Account of a Book entituled, Hesperii & Phosphori Nova Phœnomena, &c. Autore Francisco Blanchino; by John Hadley, Esq: R. S. V. Præs.*

THE Design of this Treatise, is to give an Account of some new Astronomical Discoveries relating to the Planet *Venus*, which the Author disposes under four Heads; *viz.*

1. The Description of the dusky Spots observed in her Disk.
2. Her Rotation round an Axis, the Position of which is determined by the apparent Motion of those Spots, together with the Time of her Revolution.
3. The Parallelism of that Axis to it self in all Parts of the Planets Orbit.
4. Observations in order to determine the Horizontal Parallax of *Venus*, and consequently those of the Sun and other Planets.

He takes Notice of five remarkable Spots in her whole Surface, the two smallest of which are placed, one near each Pole, the other three lie along the *Æquator*, and cover good Part of a Zone, extended to about 30 Deg. of Latitude on each Side. He represents them to be much like the larger dark Spots in the Moon, which are usually called *Seas*, but considerably fainter, so as not to be easily discernable even to a sharp-sighted Observer, without the Assistance of a Telescope, capable of representing distinctly the Planet under an Angle equal at least to that under which the Moon appears to the naked Eye, and with an Aperture of 3 or 4 Inches of the *Roman Palm*. He then proceeds to give the Description of a Machine contrived by him to represent to the Sight the Motion of the Earth and *Venus* in their Orbits, and by the Means of a Lamp placed in the Center, to shew the Phases of the Planet, and Appearance of the Curve Lines described by the Revolutions of the Spots round the Axis.

This Revolution he makes greatly different from those of the Earth and *Mars* (the two Bodies next in order of the Planetary System) both in the Position of the Axis and Time of the Period. He places the *Colurus Solstitiorum*, or Plane, passing through the Axis of the Planet and Tropical Points of its Orbit, about the 20th Degree of *Leo* and *Aquarius*, and gives the Planes of its *Æquator* and *Ecliptick* an Inclination to each other of about 75 Degrees. He determines the Time of the Revolution to be about 24 Days and 8 Hours, instead of 23 Hours, as it has been generally taken to be from some Observations made by Mr. *Cassini* in the

the Years 1666 and 1667, but which he himself did not seem much to rely on. Now, both these Periods may be very consistent with the same Observations, provided that one of the Observers did not continue his Observations for any considerable Time at once. For if the exact Situation of any Spot be observed at any given Hour one Day, and at the same Hour the succeeding Day be found advanced about 15 Degrees or $\frac{1}{4}$ of the whole Revolution, it may still remain doubtful, whether the Spot has moved only thro' those 15 Deg. in that Day, or has made one or more entire Revolutions besides in that Time. This the Author was aware of, and therefore waited for an Opportunity of attending to the Motion of a Spot as long at once as the Vicinity of *Venus* to the Sun would admit of. Accordingly, *Feb. 26, 1726*, a little after Sunset, he observed a Spot near the Center of her Disk, where their Motion is most perceptible in a short Time, and about 3 Hours after, perceived the same Spot not sensibly removed; from which he concluded, the Period of its Revolution could not be so short as one Day, since, if it were so, the Change of Place of the Spot must have been very sensible in that Time. It were to be wished the Author had had Opportunities of confirming this Period by more Observations, especially since it was necessary to begin them soon after Sunset, and continue them till *Venus* was near the Horizon; the Strength of the Twilight in the first Case, and the Thickness of the Atmosphere through which the Planet must be seen in the latter, rendering the Observations very difficult.

The next Article of his Observations, is the Continuance of the Axis in the same Parallelism, through the whole Orbit of the Planet. This is so necessary and obvious a Consequence of the established Laws of Motion, that there needs no more to be said about it.

The 4th Article contains an Account of some Observations made to determine the Parallax of *Venus* in the Year 1716: The Method he used for this Purpose, was to take the several Distances of Time between the Appulse of the Limb of *Venus* and of *Regulus* (which Star she pass'd by about that Time) to a horary Circle very near the Meridian, and to another about 6 Hours after, which he measured by the Pulses of a Watch, of which 143 went to 1 first Minute of Time. He likewise observed the Alteration of those Distances taken at the same Hour several Days one after another, and allowing a proportional Alteration for the Time between the two Observations, he computed what the Difference of their right Ascension ought to have been in the latter of them, if there were no Parallax; then comparing this Difference with that observed, he concluded the Disagreement to be the Parallax of right Ascension. This Method the Author seems to depend on so much, as to think that an equal Degree of Exactness is hardly to be expected from any other hitherto practised: But if we consider that the whole Parallax of right Ascension amounts by his Observations to no more than 4 Pulses of his Watch, and that he allows a Possibility of an Error of near one of those Pulses in taking each of the Transits, it is evident that if such an Error be actually committed in each of the Observations on which the finding of the Parallax depends, and all of them hap-

pen to conspire the same Way, the Result of all together may possibly be greater than the whole Parallax found. Upon the whole, he makes the Horizontal Parallax of *Venus* at that Time to have been $24'' 20'''$, and that of the Sun $14'' 18'''$; but as he takes no Notice of the Latitude of the Place in deducing the Horizontal Parallax from that of right Ascension, they both ought to be encreased on that Account by about $\frac{1}{3}$, or in Proportion of 3 to 4. If therefore there be no other Mistake in his Numbers, the Horizontal Parallax of the Sun, as deduced from his Observations, should be about $19''$.

He concludes with giving some Cautions to those who may attempt hereafter to repeat these Observations, both in Regard to the Time proper for it, and the Choice and Constitution of the Telescope to be made use of. For greater Ease of the Observer, there is at the End a double Table, containing the Heliocentric and Geocentric Motions of *Venus* for eight Years; after which Space of Time; the Earth and *Venus* return very nearly to the same Situation. In this Table he says are marked the most convenient Times for observing; but these Marks, by some Oversight, are omitted in the Table.

For a Telescope of 100 *Roman* Palms he allows an Aperture of 3 or 4 Inches of that Palm, with an Eye-glass whose focal Length may be from 7 to 11 of the same, but what he directs in longer Instruments to increase the Breadth of the Aperture and focal Length of the Eye-glass in the same Proportion with the Instrument, must certainly be the Effect of some Mistake: For in this Case, a longer Telescope will magnify no more than the shorter, but only have the

Strength

Strength of Light in the Object encreased in Proportion to the Square of the Length.

At the End of the Treatise is subjoined a Letter from the Reverend Father *Melchior à Briga*, &c. to the Author, giving an Account of some former Attempts to discover the Revolution of this Planet round its Axis, by Mr. *Cassini*, *De la Hire*, &c. consisting chiefly of an Extract of a Letter from Mr. *Cassini* to Mr. *Petit*, printed in the *Journal des Sçavans*, 1667, Tom. ii. Edit. *Amst.* The 2d and 3d Figures which are referred to in this Letter, are inverted by the Engraver, who copied them from the Original.

VII. *Observations on a Treatise wrote by Mons. Helvetius of Paris, designed to prove that the Lungs do not divide and expand the Blood, but that on the contrary, they cool and condense it.*
By F. Nicholls, M. B. *Præf. Anat. Oxon & F. R. S.*

THE Matter in Question between the Author and Signior *Michellotti* is, whether the Lungs cool and condense the Blood, according to the Opinion of the Antients, or whether they mix, attenuate, and of Consequence expand it, according to the System of Dr. *Pitcairn*.

The Author, in order to support the Opinion of the Antients, brings several Arguments to confute the System of Dr. *Pitcairn*: The most considerable of which (and which indeed he makes his *Argumentum crucis*) is, that the right Auricle and Ventricle being considerably larger than the left Auricle and Ventricle, and the pulmonary Artery having a larger Capacity than all the pulmonary Veins taken together, the Blood must evidently occupy a greater Space before than after its Passage thro' the Lungs; and because the Difference in the Capacity of these Vessels cannot be ballanced by any Increase of the Velocity, he concludes, that the Blood is not attenuated and expanded, but must be condensed in its Passage through the Lungs. And this the Author conceives is done by the Air, which (as a Fluid relatively cold) must cool and condense the Blood, to which it is so nearly applied in the Action of Inspiration.

Had the Author of this Treatise been contented with supporting the Opinion of the Antients, without endeavouring to subvert the System of Dr. *Pitcairn*, he would probably have found many Advocates for his Doctrine, and few Opposers.

That the Blood is cooled by the Action of Inspiration, is a Matter of which I believe few Physicians doubt, when they consider that in Inflammations of the Lungs, nothing is more earnestly desired than the breathing cool and fresh Air, nor does any thing more evidently conduce to the Cure of these and other Inflammatory Dispositions, than the Use of fresh Air. But that this is the sole Use of breathing, or that this cooling Power can over-balance the Expansion from the Action of Expiration, is what I can no ways conceive.

If

If we consider the State of the Blood at its Return to the Heart, and how careful Nature has been, not to use this Blood for the Nourishment of the Lungs before it has passed through the pulmonary Vein and Artery (though it would in that Case have been as effectually cooled in the Bronchial Arteries as in the pulmonary Vessels) we are naturally led to believe, that it is some other Quality which has rendered it improper for Nourishment, and which is to be destroyed by the Action of the Lungs.

I have before allowed, that it seems almost evident that the Blood is cooled, and of Consequence condensed in the Action of Inspiration; but for the Reason mentioned, and from considering the Structure of the Parts subservient to breathing, it seems equally true, that the Blood is mixed, attenuated, and consequently re-expanded in the Action of Expiration. I shall now consider whether the Action of Inspiration so far overbalances the Action of Expiration, as to condense the Blood into a less Bulk than it had before its Passage through the Lungs.

The accurate *Santorini* of *Venice*, in the 8th Chapter and 3d Section of his Observations, has carefully examined the Fact as stated by *Monf. Helvetius*; and finding it true in that one Subject, as to the Auricles and pulmonary Vessels, but false as to the Ventricles, he proceeds to prove that this Difference in the Capacity of the pulmonary Vessels, could not be designed on Account of the Blood's being condensed in its Passage through the Lungs; because, if so, the right Ventricle ought to have been larger than the left Ventricle; and the pulmonary Artery ought, not only to have been larger than the pulmonary Veins, but

but it ought likewise to have been larger than, or at least equal to, the two *Vena Cavae*; whereas in his Subject, the two *Vena Cavae* were to the pulmonary Artery, as 228 to 188.

In the mean time, he recommends the repeating the Enquiry to other Anatomists, as doubting whether the Fact is constantly so in healthy Subjects. *Ut cæteri diligentiores Anatomici disquirant utrum ea firma & perpetua sint: an in corporibus integris.*

As such an Enquiry may be of Consequence, not only in settling the Point in Question, but in explaining other Parts of the Animal Œconomy, I doubt not but it will be agreeable to the Society; and the rather, because the Subjects from which I have taken the several Calculations, are here produced before the Society, and submitted to a Re-examination, if desired.

The Measure which I have here used is the 113th Part of an Inch.

I have taken the Triple of the Diameter for the Periphery, and computed the *Area* by multiplying the nearest whole Number to $\frac{1}{4}$ of the Diameter into the Periphery. Though this Method is not sufficiently exact to shew the real Contents of Circles, yet as my Design here, was only to find nearly the relative Contents of the several Vessels, I have chose to avoid embarrassing the Sums with Fractions.

The first Heart is of an Adult in which

The *Diam. Per. & Areas* are

Of the Vena Cava descendens	79	237	4740	
Pulmonary Artery	115	345	10005	
Superior left pulm. Vein	69	207	3519	} 12477
Inferior left pulm. Vein	73	219	3942	
Superior right pulm. Vein	49	147	1764	
Middle right pulm. Vein	40	120	1200	
Inferior right pulm. Vein	57	171	2052	
Aorta	110	330	8910	

The ascending Cava being tied above the Diaphragm, could not be measured in this Subject.

As *Monf. Helvetius* no ways mentions the Disease of which the Subject died from whom he took his Observation, so I cannot say how proper it was for such an Examination; but it is evident, his Observation does not tally with the Calculations made from this first Heart; where the pulmonary Artery is to the Sum of all the pulmonary Veins as 10005 to 12477. And yet this Subject (besides a cancerated Ovary, and a Putrefaction of the right Kidney from the Ureter's being compressed) had her Lungs full of small Tubercles, and the Glands lying between the great Divisions of the *Tracheæ* almost petrified by atheromatous Concretions: By all which it is highly probable, that the Passage of the Blood through the Lungs was very much impeded, and of Consequence, the pulmonary Artery much dilated beyond its natural Capacity.

And this I am the rather induced to believe from examining the second Heart, which is of a Child nearly twelve Months old. As to its Death, I can say
nothing

nothing more, than that its Lungs appeared perfectly sound, and of a pale clear Colour ; and therefore the more proper for an Examination of this Kind.

In this second Heart the *Diam. Per. & Areas* are,

Of the Aorta above the Coronaries	43	129	1419	
Pulmonary Artery	43	129	1419	
Superior left pulm. Vein	29	87	609	} 2088
Inferior left pulm. Vein				
Superior right pulm. Vein	26	78	507	
Middle right pulm. Vein	17	51	204	
Inferior right pulm. Vein	32	96	768	

We may here observe that the Aorta, after giving off the Coronary Vessels, is equal to the pulmonary Artery. As to the Proportion between the pulmonary Artery and Veins, the Artery in this Subject is to the Sum of all the Veins here measured, as 1419 to 2088, and yet the lower left pulmonary Vein is here omitted, as being tied too close to admit of being measured. But if we suppose the inferior left pulmonary Vein to be to the superior left pulmonary Vein in the same Proportion as in the first Heart, we shall then find its Diameter nearly 31, and its Area at least 700, which will make the pulmonary Artery in this Heart, to the Sum of all the pulmonary Veins as 1419 to 2788 ; and in that Case, the left pulmonary Veins will be to the right pulmonary Veins, but as 1309 to 1479.

. The 3d Heart is of an Abortive nearly of 5 Months :
By its Appearance, I judged it suffocated by too much
Blood. In this Subject the *Diam. Per. Areas* are,

Of the Vena Cava descendens	14	42	197	} 629
Vena Cava ascendens	24	72	432	
Aorta above the Coronaries	16	48	192	
Pulmonary Artery	20	60	300	
Canalis Arteriosus	12	36	108	
Right pulmonary Branch	11	33	99	} 198
Left pulmonary Branch	11	33	99	
Superior left pulm. Vein	11	33	99	} 294
Inferior left pulm. Vein	9	27	54	
Superior right pulm. Vein	7	21	42	
Middle right pulm. Vein	11	33	99	

The inferior right pulmonary Vein is here cut too close, and otherways injured, so that its Area cannot be measured. Nevertheless we find the remaining pulmonary Veins to the pulmonary Branches of the pulmonary Artery, as 294 to 198.

We may here observe a remarkable Difference between the Capacities of the two *Vene Cavae* taken together, and the pulmonary Artery; the two *Cavae* being more than Double the pulmonary Artery, and the pulmonary Artery still one Third larger than the Aorta. As this Difference could not arise in this Case from the Blood's being condensed by the inspired Air, so it seems a Proof, that had the Fact been true, as stated by Mons. *Helvetius*, it had nevertheless been an insufficient Demonstration of his System.

VIII. *Observationes Diversæ Lunaris deliquii die*
2 Februarii, A. D. 1728..

Observatio Lunaris Deliquii in Coll. Societ. ꝑ E S U
Romæ, A. C. 1729, die 2 Februarii tempore p. m.
vero. Communicante Rev. J. Bapt. Carbone, R. S. S.

Initium Eclipsis	7 ^h 44 ^l 22 ["]	<i>Emerfiones</i>	H.	'	"	
<i>Immerfiones</i>	H.	'	"			
Grimaldi	7 46 16	Primi Limbi } Lunaris }	10	21	38	
Kepleri	48 8	Ricciolii		23	37	
Coper- nici	{	Gri- { Initium		24	7	
		maldi { Finis		25	4	
		Arif- { Initium		34	39	
Ty- chonis	{	tarchi { Finis		36	8	
		Ty- { Initium		41	11	
		chonis { Finis		42	5	
Manilii	19 0	Heli- { Initium		47	10	
Menelai	20 50	conis { Finis		48	14	
Dionifii	23 0	Pato- { Initium		54	33	
Plinii	25 44	nis { Finis		54	57	
Maris tran-	{	Aristotelis		57	54	
quillitatis		Totius		11	2	5
Procli	{	Menelai		11	2	5
		Maris Se- { Medium		4	33	
Maris	{	renitatis { Finis		9	15	
		Poffidonii		10	36	
Crifi- um	{	Cleomedis		14	7	
		Maris Crifi- { Medii		16	20	
Lunæ totalis	{	um { Totius		17	36	
Immerfio						
Finis Eclipsis		11 ^h 20 ^l 41 ["]				
Eodem						

Eodem die distantia meridiana Centri solaris a vertice non correcta per Refractionem observata est $55^{\circ} 9' 31''$ in Gnomone, cujus meridianam Ellipsis solaris in pavimentum projecta pertransiit tempore $2' 15''$ & diameter apparens solis micrometri partes 2945 interceptit, quarum Luna paulò ante Eclipsim observata interceptit 2903.

Observationes habitæ sunt Tubo optico pedum Romanorum $8\frac{1}{4}$.

*Lunare Deliquium Parisiis observatum Eodem Die
1729. Communicatum ab Eodem.*

H.	'	"	p. m.
7	1	0	Penumbra densa
7	3	0	Penumbra densissima.
7	3	$\frac{3}{4}$	Eclipsis initium ex aliis phasibus deductum.
7	8	50	Galilæus obtegitur.
14	0		Umbra ad Aristarchum.
15	4		Aristarchus totus in umbra.
16	44		Keplerus obtegitur totus.
18	4		Umbra ad Gassendum.
19	20		Sckicardus tectus omninò.
22	0		Umbra ad Reinoldum.
22	40		Ad limbum Copernici.
23	43		Erathostenes obtectus.
25	15		Copernicus totus in umbra.
27	2		Helicon totus.
31	50		Umbra ad limbum Tychonis.
33	8		Tycho dimidius in umbra.
33	30		Ad limbum præcedentem Platonis.
33	47		Plato in umbra totus.
38	7		Ad præcedentem limbum Manilii.
39	20		Manilius totus.

11. ' "

- 7 41 45 Umbra pervenit ad Menelaum.
 42 35 Ad Menelai dimidium.
 45 22 Ad Plinium.
 49 47 Ad præcedentem Fracastorii limbum.
 50 30 Ad Promontorium acutum.
 51 24 Umbra tegit Fracastorium.
 54 30 Pertingit ad Proclum.
 55 16 Proclum tegit totum.
 56 17 Ad limbum maris Caspii.
 58 56 Ad dimidium.
 59 0 Ad limbum Caspii sequentem.
 8 2 0 Finis dubius.
 3 0 Finis certus.
 9 41 18 Emerfionis initium.
 41 33 Grimaldus incipit.
 45 40 Grimaldus emergit totus.
 49 35 Galilæus.
 51 30 Sckicardus.
 54 34 Capuanus.
 55 16 Aristarchus incipit.
 56 5 Totus extra Umbram.
 58 35 Keplerus totus.
 10 0 30 Primus Tychonis limbus.
 1 30 Dimidius Tychon extra umbram.
 2 30 Emergit totus.
 3 40 Lasbergius & Reinoldus.
 5 19 Incipit Copernicus.
 6 43 Copernicus totus.
 7 33 Emergit Erathostenes.
 8 0 Totus Helicon.
 12 56 Plato incipit.

H.	'	"	
10	14	15	Totus extra Umbram.
	20	35	Manilius incipit.
	21	28	Totus emergit.
	23	50	Menelaus.
	27	25	Plinius.
	30	19	Dionysius.
	31	0	Promontorium acutum.
	36	15	Proclus.
	37	26	Incipit Mare Caspium.
	41	24	Finis dubius.
	42	0	Finis certus.

Observatio paucarum, quæ ferme omnes trans nubes tenues conspectæ sunt, Phasium Defectus Lunæ, habita (tubo optico optimæ notæ, longo pedes Parisienses septem) Patavii. Idibus Febru. Anno a R. S. 1729. à Cl. J. Poleno Astr. Patav. & R. S. S.

Temp. Appar.

H.	'	"	
p. m.			Observationem Initii Defectus nubes densæ impedivere:
7	44	40	Umbra attingit Grimaldum.
7	45	40	Grimaldum tegit totum.
7	50	53	Attingit Mare Humorum.
7	53	26	Tegit Maris Humorum dimidiam partem.
8	19	34	Tegit Menelaum.
8	38	10	Cooperit totum Mare Crisium.

Per

			{ Per dehiscences nubes Luna admodum rubicunda observari poterat perspicue adeo, ut non meminero aliàs in totali immersione tam clare Lunam apparuisse; quod ita fortasse visum est ob atram obscuritatem, quam circumpositæ densæ nubes efficiebant.
9	26		{
10	15	6	{ Umbra dilui incipit è regione proximæ emersionis.
10	26	45	{ Grimaldus, jam emersus, ab umbra distat tota fere sua transversa diametro.
10	38	45	{ Dimidium Mare Humorum discoopertum Tycho totus emergit.
10	50	12	{ Apparet Erathostenes.
11	13	27	{ Promontorium Somnii totum discoopertum.
11	19	45	{ Luna infici videtur sola penumbra.
11	20	56	{ Finis etiam penumbrae.

IX. *Observationes quædam Eclipsæ Lunaræ Die 29 Julii habitæ A. D. 1729.*

Observatio Eclipsæ Lunæ totalis, A. 1729 mane d. 9. Augusti Stil. Nov. habitæ Witebergæ Saxonum, à Jo. Friderico Weidlero L. L. D & Math. Prof. Ordinari. Communicante Hans Sloane Baro-netto R. S. Præf.

I Nitium sub Grimaldo. Mane d. 9 Aug. } H. 1 11
 temp. Europ. } 0 1 30
 Umbra

		H.	'	"
Umbra tangit	{ Galileum	-	0	3 45
	{ Aristarchum	-	0	6 0
	{ Keplerum	-	0	11 0

Postea nubes condunt lunam.

Tegitur mare Crisium dimidium	-	-	0	54	0
M. Crisium totum	-	-	0	57	0
Immersio totalis	-	-	1	1	0
Emergio	-	-	2	40	30
Emergere incipit	{ Galileus	-	2	43	30
	{ Aristarchus	-	2	45	0
	{ Keplerus	-	2	49	0
	{ Copernicus	-	2	54	45
	{ Plato	-	2	55	30
	{ Timocharis	-	3	1	30
	Manilius	-	3	4	0
Emergit totus Tycho	-	-	3	8	30
Emergere incipit	{ Menelaus	-	3	10	30
	{ Plinius	-	3	13	0
	{ Cleomedes	-	3	18	0
M. Crisium & una M. Nectaris	-	-	3	23	30
M. Nectaris totum emergit	-	-	3	29	0
M. Crisium totum emergit	-	-	3	31	30
Incipit emergere Langrenus	-	-	3	34	30
Finis	-	-	3	40	0

Exeunte umbra inter Langrenum & Petavium.

Observatio Defectus Lunæ habita (tubo optico, longo pedes Parisienses sex) Patavii ab Cl. J. Poleno.
R. S. S. Die 29 Julii 1729. S. V.

Temp. Appar.

H.

o	o	28	Initium umbræ ad Lunæ Limbum.
13	55		Umbra tangit Copernicum.
15	49		Hunc totum tegit.
22	24		Attingit Tychonem.
24	14		Totum Tychonem cooperit.
28	40		Attingit Manilium.
30	15		Hunc totum cooperit.
33	2		Menelaum tangit.
34	22		Menelaum omnino cooperit.
49	10		Attingit Mare Crisium.
54	56		Mare Crisium totum cooperit.
58	48		Totalis Immerfio.
2	37	38	Lux in Lunæ margine.
	41	20	Grimaldus extra umbram.
3	4	15	Mare Serenitatis emergere cœpit.
	6	16	Tycho totus emergit.
	7	28	Manilius totus discoopertus.
	10	30	Menelaus extra umbram.
	13	58	Mare Serenitatis totum emerfit.
	21	48	Promontorium Somnii jam extra umbram.
	23	10	Mare Crisium incipit emergere.
	25	28	{ Totum Mare Nectaris extra umbram, & dimidium Mare Crisium.
	29	o	Mare Crisium integrum apparet.
	33	20	Langrenius extra umbram.
	38	8	{ Finis Emerfionis ab omni etiam penumbra.

F I N I S.

ALGER
Or the
DESERT

To the Honourable
St Hans Slane Bar^t President of
the Royal Society &c. this Map of the
KINGDOM of TUNIS
is with all Respect dedicated
by his most obedient
and humble Servant
Thomas Shaw

Alger July 7th 1720

THE
COUNTRY OF
DATES

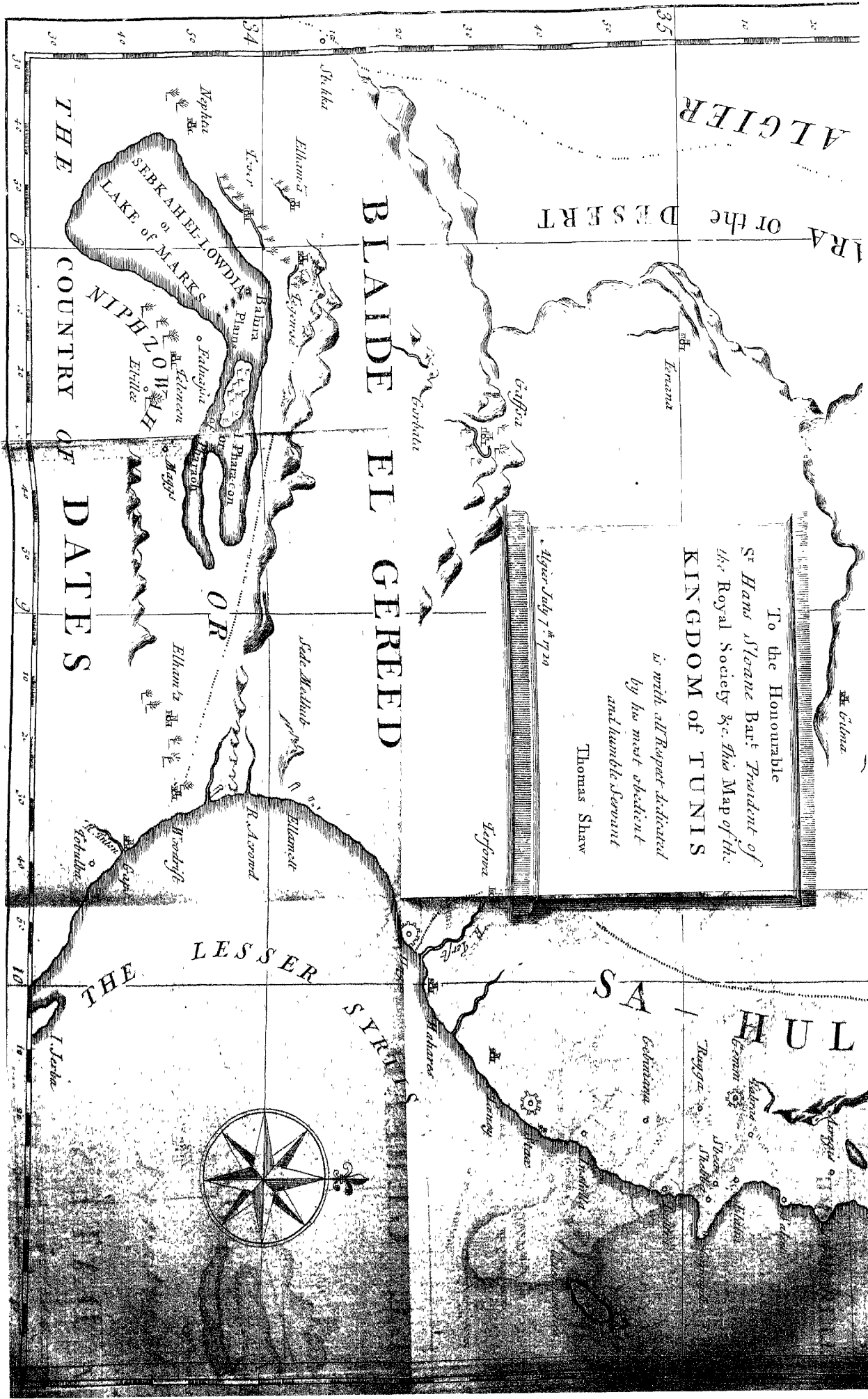
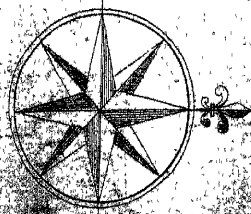
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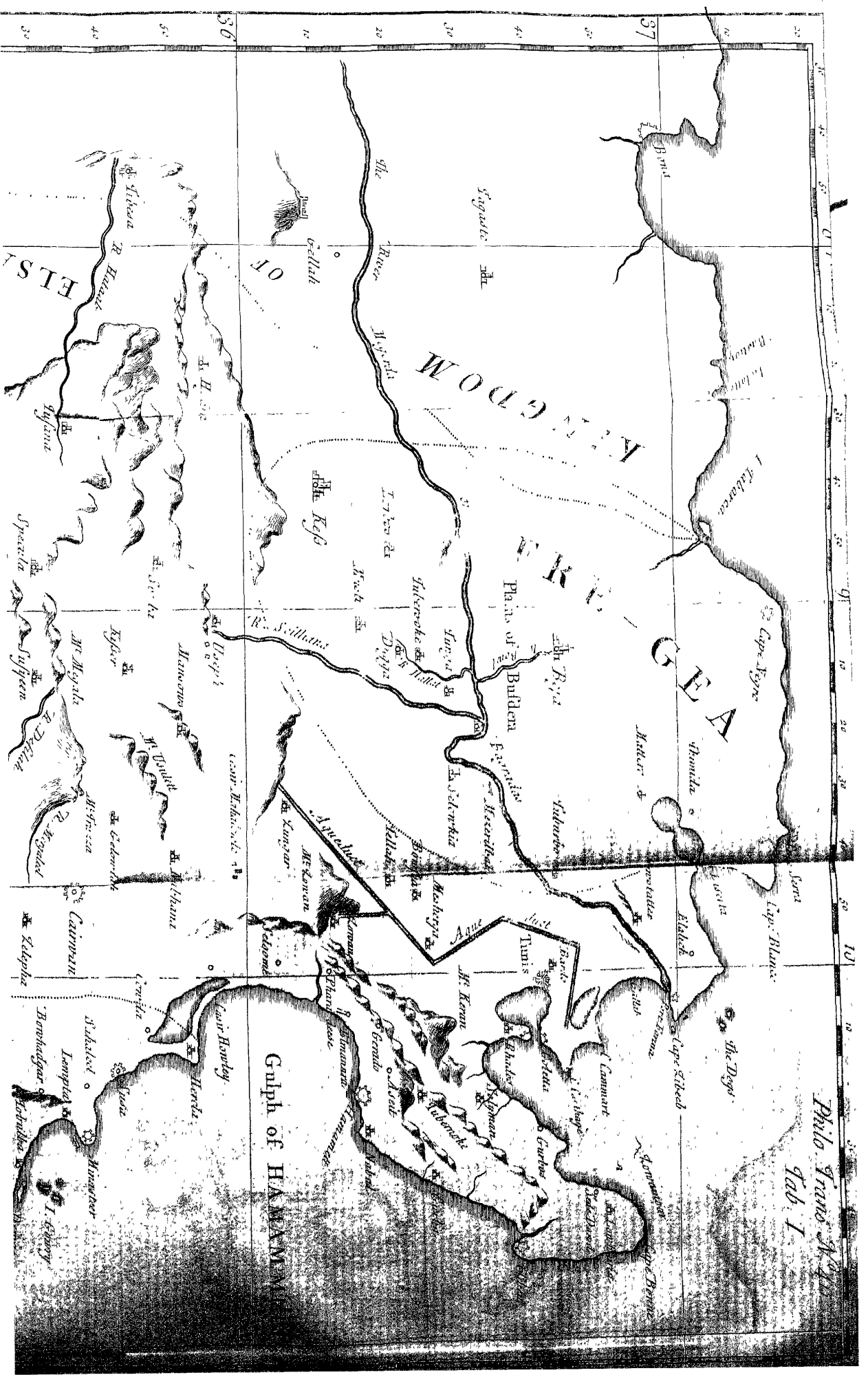
SEBKAH EL LOWDIA
LAKE of MARKS
NIPH 20 Wth
Elville

OR

THE
LESSER

SA
HUL





Phil. Trans. Vol. 44
Tab. 1

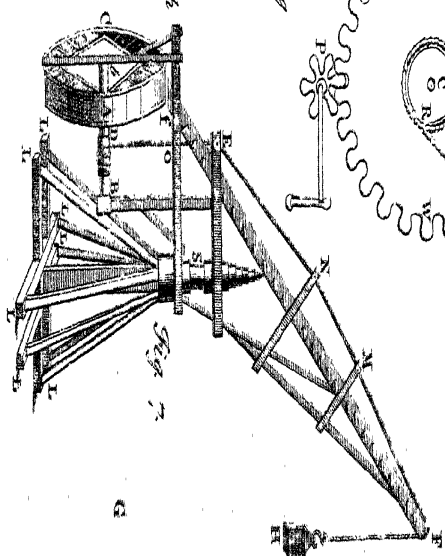
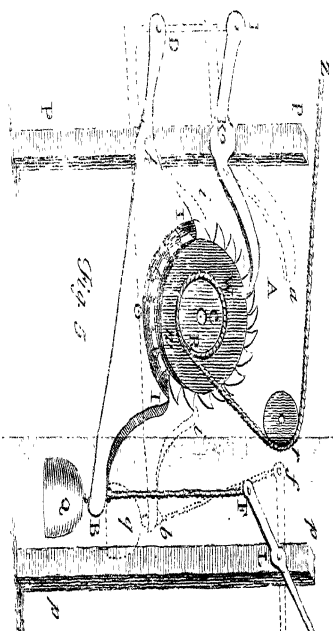
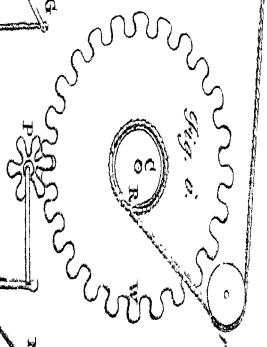
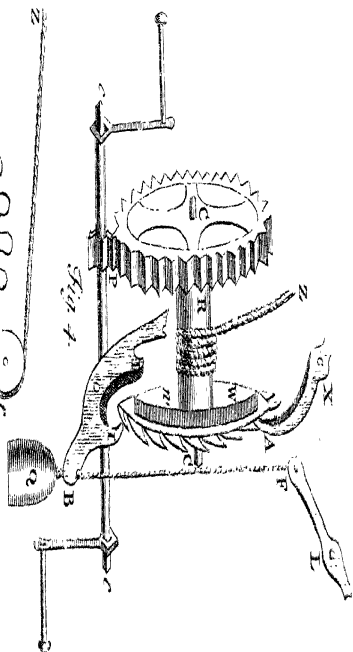
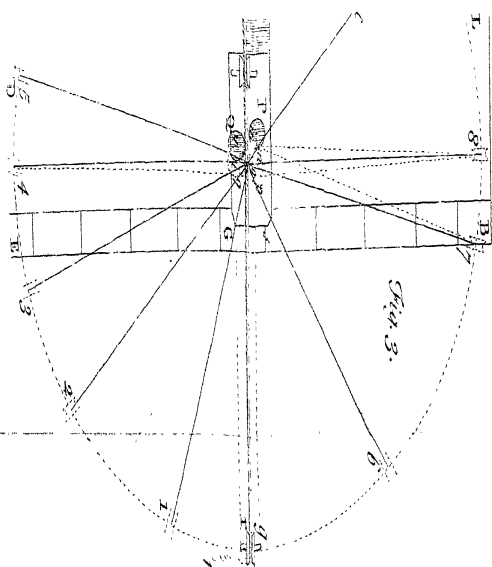
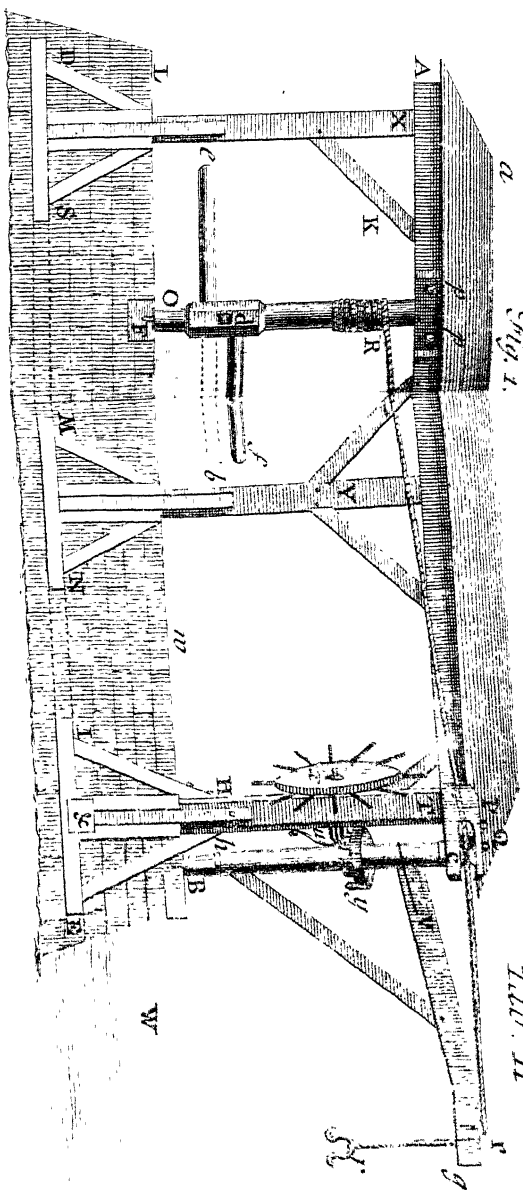


Fig. 1.



Wheeler's Improved No. 411.
Tab. II.

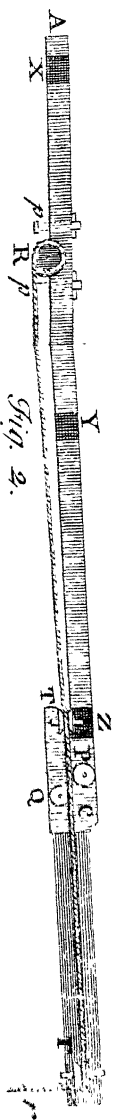


Fig. 2.

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *October, November and December, 1729.*

The CONTENTS.

- I. *A Letter to Sir Hans Sloane, Bart. R. S. Præf. containing a Geographical Description and Map of the Kingdom of Tunis, with a Postscript relating to the Cure of Intermittent Fevers in those Parts, &c. by the Reverend Mr. Tho. Shaw, Chaplain to the English Factory at Algier.*
- II. *A brief Account of some of the Effects and Properties of Damps, in a Letter to William Rutty, M. D. R. S. Secr. from Mr. Isaac Greenwood, Professor of Mathematicks at Cambridge, New England.*

III. *A*

The CONTENTS.

- III. *A Letter from the King's Officers at Sheerness and Chatham, to the Honourable the Commissioners of the Navy, giving an Account of what they met with in opening an antient Well near Queenborough in Kent, communicated by Mr. Peter Collison, F. R. S. on January 8, 1729.*
- IV. *Some Observations on the Crane, with Improvements on that Machine, by J. T. Desaguliers, F. R. S. Shewn the Society in Models, but here exemplified by Figures.*
- V. *Of the Meteor called the Ignis Fatuus, from Observations made in England, by the Reverend Mr. W. Derham, F. R. S. and others in Italy, communicated by Sir Tho. Derham, Bart. F. R. S.*
- VI. *Duæ Observationes Eclipsis Lunæ Totalis Nocte sequente Diem 28 Julij 1729. S. V. Communicante Cl. Thomâ Derham, Bart. & R. S. S.*

- I. *A Letter to Sir Hans Sloane, Bart. R. S. Præf. containing a Geographical Description and Map of the Kingdom of Tunis, with a Postscript relating to the Cure of Intermittent Fevers in those Parts; By the Reverend Mr. Tho. Shaw, Chaplain to the English Factory at Algier.*

S I R,

Algier, July 9. 1729.

THIS waits upon you, with a Map of the Kingdom of *Tunis*, which I have very faithfully laid down, according to the Observations I lately made in those Parts. From *Tunis* I travelled as far Westward as *Hydra*, and from thence went to *Tofer*, passing from *Tegewse* through the *Lake of Marks*, or the *Palus Tritonia*, as I take it, to *Gaps*; from *Gaps* I travelled all the Way upon the Coast to *Biserta*; but at the same Time took Care to visit such Places within Land, where I could learn of any Ruins or Curiosities. I made use of a small, but very good Mariners Compass, and found the Variation at *Cairwan* 10 Degr. West; at *Biserta* something more than 12 Degr., and at *Algier* I find it now to be 30 Degr. 30 Min. I carried along with me likewise a Brass Quadrant of a Foot Radius, and took the Latitudes of *Tunis*, *Cairwan*, *Spetula*, *Gaffsa*, *Tofer*, *Ebillee*, *Gaps*, *Stax*, *Susa*, *Lowbaria* and *Biserta*, with all the Exactness such an Instrument would admit of. As to the Longitude, most Mariners whom I have conversed with, agree within 10 or 12 Miles, that the Distance between *Algier* and the *Gulletta* (or Port of *Tunis*) is 400 Miles. I have

B b

made

made this Voyage four Times, and the Reckonings we made aboard, amounted only to 390. I have made therefore the Meridional Distance betwixt this Place and Cape *Carthage* 350 Miles: (allowing 48 to a Degree of Longitude) for as this whole Course is not upon the same Parallel, we may very well allow 40 or 50 Miles for the oblique Sailing; because the Course is in 37 Degr. 20 Min. N. Lat. but *Algier* lies in 36 Degr. 48 Min. and the *Gulletta* in 36 Degr. 40 Min.

The Civil War which unfortunately broke out in this Kingdom (*i. e.* of *Tunis*) when I was preparing to return by Land to *Algier*, disappointed me of seeing some few Places to the Westward, and of continuing my Voyage through *Theveste*, *Lambesa*, *Cirta*, *Sitifi*, &c. to *Algier*. But I intend, God willing, to take these in my Way to *Italy*, and shall then lose no Time or Opportunity of making what further Discoveries I can in those Parts, and of laying before you the Geography and Antiquities of the *Mauritania Cesariensis* and *Sitifensis*; of the *Numidia* betwixt the Rivers *Ampsaga* and *Tusca*; as well as of the *Africa propria* of *Pliny*, and the *Bizacium* of *Strabo* and *Ptolemy*, which I am now going to give you some Account of.

The Kingdom of *Tunis* is bounded to the North and East with the *Mediterranean Sea*, to the West with the Kingdom of *Algier*, and to the South with that of *Tripoly*. It is 230 Miles in Length from the Isle of *Gerba*, in Latitude 33 Degr. 24 Min., to Cape *Serra*, in Latitude 37 Degr. 16 Min. and 128 Miles in its greatest Breadth from *Monaheer* to *Tibéfa*. *Sbeka*, its utmost Boundary to the West,

West, lies in Longitude 7 Degr. 26 Min. and *Clybea*, its utmost Boundary to the East, in 10 Degr. 47 Min. from *London*.

Of the modern Geographers, *Luyts* seems to have been the best acquainted with its Extent in general, giving it 3 Degr. of Longitude, and (above) 4 Degr. in Latitude. The *Sançons* place it above 3 Degr. further to the South than it should be, and their Error is greater, in relation to the Longitude. *Moll* places it a few Minutes only too far to the North, but to the South he has extended it beyond the Parallel of *Tripoly*, wherein I find he has been followed by Mr. *De Lisse*, in his Map of *Africa*, 1722. But a long Chain of Mountains which run in the same Parallel of Latitude with *Gerba*, are the Limits of *Tunis* and *Tripoly*.

If we take the Antients for our Guides, we shall still find further Errors and Disagreements. For *Ptolemy* makes the Difference of Latitude betwixt *Carthage* and *Gaps*, almost the two Extremities of the Kingdom, to be only 1 Degr. and 50 Min. (provided the *Italian* Copy I make use of be correct) The like Distance he puts between *Gaps* and *Tofer*, making thereby the latter 110 Miles more to the South; whereas I found it 18 Miles more to the North. Thus again he places *Gaffsa* in Latitude 29 Degr. 45 Min. and *Gaps* in 30 Degr. 30 Min. making *Gaps* a great Way to the North; whereas the Course from *Gaffsa* to *Gaps*, is near 80 Miles South-East: not to speak of his placing *Carthage*, and so respectively of other Places, too far to the South by near 4 Degr. 30 Min. or 270 Miles. The like Errors may be observed as to his Difference of

Longitude of particular Places, and as to his Scale of Longitude in General, which he places at least 10 Degr. too far to the East.

The *Antique* Itinerary will also admit of several Doubts and Contradictions, as *Ricciolus* has already observed, *Geogr. p. 74*, and therefore is not to be altogether depended upon; though it must still be allowed to be a much better Conductor than *Ptolemy*. Thus the Author of the *Itinerary* makes it to be 216 Miles from *Suffetula*, I presume by the Way of *Adrumettum*, to *Clypea*, thereby making *Clypea* 111 Miles from *Adrumettum*; whereas in another Place, in his *Maritime Itinerary*, he only makes a Difference of about 44 Miles, or 350 Furlongs. And again he makes the direct Road from *Carthage* through *Laribus* and *Theveste* to *Cirta*, to be 332 Miles; but the Road by *Hippo Regius*, or *Bona*, which should be further, only 312. So that great Caution is to be observed in following that Authority.

Pliny is not so particular as either *Ptolemy* or the *Itinerary*. He lays down Things in general, and therefore can give but little Light and Assistance to a Traveller, in pointing out to him the antient Boundaries, or the particular Cities of this Kingdom. His Alphabetical Collection of Towns, has but little Instruction in it, and where he would seem to follow some Order and Method, as in naming the Towns along the Coast of *Bizacium*, he places *Adrumettum* and *Ruspina* after *Leptis*; thereby insinuating, as if *Leptis* lay at a greater Distance from the lesser *Syrtis*; the contrary to which is proved easily from *Hurtius* and other Authors. And if with *Cluverius*,

rius, &c. we should make the *Africa* of *Pliny*, comprehending even the two Provinces of *Zeugitana* and *Bizacium*, to be the Kingdom of *Tunis*, we shall meet with great Difficulties in the Geography, especially of *Bizacium*, which is the Southern, and ought to be the greater Part of it. For as *Pliny* makes it only 250 Miles in Circuit, and to extend from *Adrumettum* or *Hercla* North to *Sabrata*, or to *Gaps* only, or *Tacape* South, we shall find that this Number of Miles will not be sufficient to measure the Coast twice over, and therefore can lay no Claim at all to any Part of the Continent. But how far short soever this Calculation may be of the Truth, it seems very probable, that the Province of *Adrumettum*, as described by *Ptolemy*, how faulty soever he may be in Particulars, is the *Bizacium* which we look after, and that it included the *Blaide el Gereed*, or *Country of Dates*, which *Pliny* and the Author of the *Itinerary* seem to have known nothing of, or not to have regarded. For *Ptolemy's* *Ufulitanum*, *Turza*, *Zugara*, Cities still preserving their old Names, and near upon the same Latitude with *Adrumettum*, continue to remain its Boundaries to the North; as *Tofer* and *Gaps*, the *Tifuro* and *Capi*, or *Tacape* of the Antients, do to the South; while *Teney* and *Gaffsa*, or the antient *Thæne* and *Capsa*, determine the Midland Continent. And in this Situation, * *Strabo* seems to place his *Bizacū*; and at the same Time makes the Country of the *Carthaginians* to be only the *Zeugitana* of *Pliny*,

* Supra Syrtis Pſyllos atque Naſamones atque Getularum aliquos: deinde Syrtis & Byzacios usque ad Carthaginienſem regionem: ea enim est multa. *Strab. Geogr. l. 2.*

contrary to the Opinion of some Geographers, who give it a much greater Extent. However the *Zeugitana*, or the greater Part of it at least, is still called *Fregēa* or *Fritlea* by the *Arabs*; and as this is without doubt a Corruption of its antient Name, so the Tradition of it through so many Ages, may perhaps be a stronger Argument, that this was the *Africa* properly so called of *Pliny*, or the Province of *Africa*, by Way of Eminence, than most of the Geographical Reasons which have hitherto appeared to the Contrary.

The Kingdom of *Tunis* then contains the *Africa propria* of *Pliny*, with the *Bizacium* of *Strabo*, or the Province of *Hadrumettum* of *Ptolemy*, to which we are likewise to add so much of *Numidia* as lies half a Day's Journey, or six Leagues West of *Keff*; for *Keff* or *Sicca Veneria* is now Part of these Dominions, and which *Ptolemy* and *Pliny* place in *Numidia*, though it is almost in the same Meridian with the River *Tusca*. I am with all Respect,
Sir,

Your most obedient and humble Servant,

Tho. Shaw.

P O S T S C R I P T.

S I R,

July 15.

BY a Letter just received, I am advised, that most Parts of *England* have suffered very much this Year by Intermitting Fevers; and as we have a Species of the *Scabiosa* here, which is of
great

great Virtue in removing that Distemper, I thought proper to send you a Specimen of its upper Leaves, for the lower are at present dried up. It is not unlike the Figure which *Morison* gives of his 20th Species, Cap. XXI. Sect. 6. Tab. 14, or of his 25th Species, Cap. XXI. Sect. 6. Tab. 15. of Corymbiferous Plants, only the Head is not round, as there described. I have therefore presumed to call it, *Scabiosa, flore pallide purpureo, capitulo oblongo, foliis superioribus incis, inferioribus integris, serratis*. The Method of preparing it is to put a Handful of it into a Quart of Water, and boil it away to a Pint. A Coffee-Dish full of this Decoction is given Fasting, a little before Dinner, and at Night, to the Patient, no Regard being had to the Interval or Intermision of the Fit, as in giving the Bark; and it operates ordinarily by Stool or Urine. I have only seen this Plant *here*, at *Oran*, *Gibraltar*, and *Mount Libanus*, where I first was acquainted with its extraordinary Qualities. If it is not known in *England*, though I think Mr. *Bobart* shewed me it at *Oxford*, please to advise me, and I shall send you a Quantity of it dried, and the Seed of it, from this Place. There are other Herbs here made use of in different Distempers, and oftentimes with Success, and which I shall give you an Account of in the Natural History of this Country; but none is in so much Vogue and Esteem, as the Herb I have now described to you. How far its Virtues may be altered, diminished, or entirely lost in another Climate, Experience alone can teach us; only I can assure you, that in this, the Use of it for a few Days has been known to re-

move the most inveterate Cases. I am with all Respect, Sir,

Your most obedient and humble Servant,

Tho. Shaw.

II. *A brief Account of some of the Effects and Properties of Damps, in a Letter to William Rutty, M. D. R. S. Secr. from Mr. Isaac Greenwood, Professor of Mathematicks at Cambridge, New England.*

S I R,

YOUR obliging Letter I received not till about Half a Year after the Date thereof; and have been lead on to so long and criminal a Delay of my Answer, in Hopes of procuring something that might be worthy of your Notice.

I have now sent you inclosed, a brief Account of two Instances of the deadly Effect of vitiated Air upon Animal Life.

If such Experiments as I have made on the Damp therein mentioned, be of any Importance in the Discovery of the true Cause of this wonderful *Phenomenon*, I shall have attained my End. I take the Liberty to write my self,

Your most obedient humble Servant,

Cambridge, New England,
Howard Colledge, May
10. 1729.

Isaac Greenwood.

Mr.

Boston, July 19. 1729.

MR. *Adams* and his Servant being employed to repair a Pump in this Place, about six o' Clock this Afternoon uncovered the Well ; upon which he immediately attempted to go down, by Means only of a single Rope ; but had not descended above five or six Feet, before he was rendered incapable of sustaining his Weight, and without speaking, or any Signals of Distress, slipped down suddenly to the upper Part of the Joint of the Pump ; where being supported about a Minute, fetching his Breath in a very distress'd Manner, he fell to the Bottom, which was about eight or ten Feet lower, and covered with but a very few Inches of Water, without discovering any Signs of Life. Hereupon his Servant (*Thomas Reardon*) with great Precipitation took the Rope in his Hand, in order to descend to the Relief of his Master ; but at the same Distance from the Top, met with the same fatal Interruption ; and without discovering any Signs of Distress, was heard to fall to the Bottom.

The Workmen above prepared a *Third* with a Tackle about his Wastle. Upon his Descent he was rendered Speechless, and made no Signs at all, though he had agreed to it ; whereupon being raised from the Well, he was found to have the Image of Death impress'd upon him ; but upon the Use of proper Means was soon recovered, without remembering any thing particularly that had passed.

Some Hours after this the other Bodies were taken up ; but, as we had before been well assured

it would be, with all the Marks of a violent Death upon them.

There was nothing particular relating to this Well, excepting that it was nearly situated to the Town-Dock, the *Reservoir* of all the Dregs of the Neighbouring Streets; and is about 30 Feet deep, which in this Place is so considerable, that it is lower than the Surface of the Water at the greatest Ebb. There had not been an *Air-Tube*, or Passage for the external Air to communicate with it for some considerable Time.

This Evening several Trials were made on *descending Lights*; particularly, by letting down *lighted Candles* uncovered, others inclosed in Lanthorns, and others with the Lanthorn placed in a Pail; but in all these Endeavours it was observed, that whatsoever the Circumstances of the descending Light were, it never reach'd above six Feet.

July 20. I repeated this Evening such Experiments in the *Damp* as related to *Flame*, and found the Effect much the same as before; *viz.* in about 6 Feet below the Top of the Well, the Flame would grow dim, and if not immediately raised, would change to a bluish Colour, and become more and more contracted or diminished, till in about a Minute's Time it would be totally extinguished, without any Remains or Stench accompanying the Wick. In these Experiments I particularly observed, that the *Flame* in all its Changes still continued its Pyramidical Figure; nor did a quicker or slower Descent make any Alteration in these Circumstances. One Experiment was very particular, relating to the Flame of a Candle.

dle. We took a common Pail, and having fix'd a Candle to the Bottom thereof, erect, about 8 Inches long, we poured as much hot Water into the Pail as reach'd within a quarter of an Inch of the Blaze of the Candle. Then having carefully lowered the Pail down the Well, the Flame, notwithstanding it was defended by the reeking Steams of the hot Water, went out at the same Depth, and in the same Time as it did before. After this we immers'd burning Coals, flaming Brimstone, and lighted Matches, all which were extinguish'd with very little Difference as to the Time, or other Circumstances.

Two Experiments were made relating to *Animal Life*. A large *Kittling* was very much affected in about a Minute's Time; and after 3 Minutes was rendred so weak, that after she was taken out, she could not sustain her Weight on her Legs. Being at length pretty well recovered, we carefully bound her up in a Silk Handkerchief, that she might be the more easily suspended; and having let her down about 16 or 18 Feet, in three Minutes she was affected in the like Manner as before, making a very distress'd Noise, and in about five Minutes was in such extraordinary Convulsions as rendered the Sight not a little disagreeable; but in these Throws she disengaged herself from the Handkerchief, falling to the Bottom, without making any Efforts to swim; whence we concluded they were the last Struggles for Life, in which she broke loose.

We tried the same fatal Experiment upon a small Bird, which being suspended in the *Damp* about three Minutes, was found entirely senseless, and ac-

ording to all Appearance past Recovery. Upon taking it in my Hand, I found it was very cold, nor had it the least Motion that I could discover ; however, keeping of it close between my Hands, which were pretty warm, in about a Minute I felt a small Palpitation, which presently increased to a stronger Pulse, till in about six or seven Minutes the Bird was restored to a perfect and uninterrupted Respiration. About half an Hour after this, we again put the Bird into the *Damp*, and continued it there about five Minutes, after which we found it past Recovery.

July 21. I repeated several of the Experiments relating to Lights and Flame, which succeeded with very little, if any Alteration, as before ; which we looked upon as an undoubted Confirmation of the Continuance of the *Damp*. Whereupon we proceeded ; first, to examine the Elasticity of the Air in the Well, by letting down a small Bell, the Sound of which was as distinct and loud, as in any ordinary Well of the same Depth.

Then to discover the Degree of Moisture, we took a large Sponge a little wet, which with the *Silk String*, whereby we let it down, weigh'd 278 Grains. This being suspended in the *Damp*, upwards of five Minutes, and then raised, was carefully weigh'd, and found to be of the same Weight precisely. After this we dried the *Sponge*, which then weigh'd but 261 Grains, and having applied it to the *Damp* for the Space of ten Minutes, we found also, that it had not gained the least Part that could be perceived in its Weight. Also, a large Bundle of *Catgut*,

gut, weighing two Ounces fifteen Penny-weight ten Grains, acquired not the least Augmentation thereto, by being suspended for a very considerable Time.

To these Experiments we added one upon the *Hydrostatical Ballance*, in order to determine whether there was any extraordinary Difference as to the Density, or Specifick Gravity of common, and this vitiated Air. The *Ballance* we made use of was very large, and accurately poiz'd, and the *Solid*, which was a Globe, was four Inches eight tenths in Diameter. This with its String weigh'd in the Air seven Ounces six Penny-weight. And after we had immers'd it in the *Damp*, it lost nothing of its Weight, being then in *Æquilibrio* to so great a Degree of Exactness, that half a Grain would over-ponderate on either Side.

This *Damp* abated more and more by being exposed to the Air, till on *July* the 25th, Persons were let down to the Bottom without any Inconvenience.

The other Instance is of a very sudden Subterraneous Vapour, on *May* 9, 1729, in a Well in *School-house-Street, Boston*.

This Well had been opened for some considerable Time; and not only enlarged in its Diameter, but sunk fourteen or fifteen Feet deeper. Hercupon Mr. *Rennie*, and a young Man whose Name was *Russel*, undertook to lay the Stones. They had been employ'd all the Day, till about six o'Clock in the Afternoon, when *Rennie* perceived a very unusual Stench, of which he first upbraided his Partner as an Act of Indecency, till by the extraordinary
Increase

Increase thereof, he was apprehensive of some greater Danger. *Russel* was hitherto unsensible thereof, but perceiving his Partner's Visage to change to a very uncommon Degree, call'd up for Relief; at which Instant, as he afterwards expressed himself, *He first perceived a very strong noisome Smell, resembling rotten Fish, which on a sudden seized his Senses, and rendered him unable to sustain his Weight.* *Rennief* had immediately closed his Mouth and Nostrils with his Hand; and when the Bucket was lowered with a *third* Person for their Relief, assisted in getting *Russel* into it. As the Bucket was raising, *Russel* was taken with very unusual and extraordinary Fits; and when he was laid upon the Ground, till *Rennief* was taken out, could scarce be kept still by the united Strength of three or four Persons; but bounding and writhing his Body, like a Fish newly taken from the Water. *Rennief* was affected only with fainting Fits. After three Hours *Russel* recovered of these extraordinary Convulsions, but was disordered in his Brain during the whole Night; and though *Rennief* was sooner relieved of his Fits, he continued extreamly disordered for a longer Time. It was thought remarkable, that neither of them was affected with either Vomiting or Purging.

This Accident happened on *Friday*, and on the *Monday* they were both restored to perfect Health. The Well continued infected for a very little while, and when on the *Monday* following some other *Workmen* renewed the Work, there was nothing Noisome that could be perceived.

I can.

I cannot call to Mind, that there is any Instance of such a tranſient Vapour or Damp recorded in the *Royal Transactions*; and muſt confeſs I am at a Loſs how to account for it. Should there be Subterraneous Exhalations which, like the Clouds or Wind in the Atmosphere, ſhifted from one Place to another, it might be of great Importance to obſerve the Particulars thereof, eſpecially ſuch as are *Malignant*, as this was. The Paſſage of this Vapour was about 25 Feet below the Surface; a Depth too great for it to affect Cellars or Vaults.

I had forgot to note, that this Part of the Town lies very high; and the Ground for about ten Feet, hard Clay, and the reſt a coarſe Sand and Gravel.

III. *A Letter from the King's Officers at Sheerness and Chatham, to the Honourable the Commissioners of the Navy, giving an Account of what they met with in opening an antient Well near Queenborough in Kent, communicated by Mr. Peter Collison, F. R. S. on January 8, 1729.*

Chatham-Dock, Octob. 9. 1723.

Right Honourable,

IN Obedience to your Honours Warrant of the 16th of September laſt, we met at the Well near *Queenborough*, where the Caſtle formerly ſtood, on *Tueſday* the 24th *ditto*, and finding but very little Wa-

rer at the Bottom on our Sounding, and it having a new Curb, lately fix'd on the Top, we provided ourselves with Buckets and Ropes, and lower'd down a Man, who acquainted us, that it was clean'd, and the Ground sunk four Feet deeper than the Curb at the Bottom. We then measur'd the Depth of it, and found it 200 Foot, and artificially steen'd the whole Depth with circular *Portland* Stone, which is all entire, and stands fair, the mean Diameter is four Foot eight Inches ; but observing, that not one Drop of Water came into it, we resolv'd to try whether we could find any by Boring ; in order thereunto, we applied ourselves to make the necessary Preparations, by getting a Piece of Timber of about seven Foot long, and boring it through with a three Inch and a half Auger, which Trunk we fix'd at the Bottom of the Well, and fasten'd it by Quarters to the Curb at the Bottom, to prevent its raising, and fill'd it all round three Foot deep with Clay, and on that laid four Course of Bricks for a Platform for the Men to stand on in their boring, and got also an Auger of two Inches and half, to bore through the Clay, but could not get all the necessary Appurtenances till *Thursday* the 26th of *September*, when three Men at a Time began to bore, whom we shifted every three Hours ; the Boring which they sent us up, was a very close bluish Clay, which continuing the same after three Days and a half boring, we began to despair meeting with Water ; but on *Monday* the 30th of *September*, in the Evening, as they were boring, the Auger slipt down at once, and up came Water, to our great Satisfaction ; and in
an

an Hour's Time there was upward of four Foot Water, which rose so fast, that at twelve o' Clock at Noon,

Feet. Inch.

On the first of *October*, we found - - 55 10

On the 2d, at 5 in the Afternoon, - - - 109 08

On the 3d, at 3 in the Afternoon, - - 132 06

On the 4th, at 3 in the Afternoon, - - 149 06

On the 5th, at 4 in the Afternoon, - - 161 03

On the 6th, at 10 $\frac{1}{2}$ in the Morning, - - 167 08

On the 7th, at 4 in the Afternoon, - - 174 00

On the 8th, at 7 in the Morning, - - - 176 07

and still increafes, though slowly. The Reason of its not rifing fo much now as at firft, we apprehended proceeded from the Weight of Water which the Spring through the Hole of the Trunk muft force up, and the Well being wider aloft than below. What we think very extraordinary is, that we bored 81 Feet below the Foot of the Trunk before we met with this Body of Water, which by Computation is 166 Feet below the deepeft Place in the adjacent Seas. The Water proves excellent good, foft, sweet and fine; we compar'd it with the beft Spring Water brought from *Milton*, and in every Body's Opinion that tafted both, they declar'd the Well-Water the beft. We put fome Soap to it, and it Lather'd finely; we boil'd old Peafe in it, which performed very well, and we have great Reason to believe, that the Spring will fufficiently fupply his Majefty's Ships, as propofed.

Signed by

Richard Frost, James Young, Edmond Oxley,

Benj. Roswell, Richard Stacey, J. Hayward,

D d

John

John Ward, William Hogg, J. Dod, Charles Finch, D. Devert, William Jones,
King's Officers at *Sheerness* and *Chatham*.

IV. *Some Observations on the Crane, with Improvements on that Machine, by J. T. Desaguliers, F. R. S. Shewn the Society in Models, but here exemplified by Figures.*

THE Crane is an Instrument so much used, and so well known, that it wou'd be needless here to give a particular Description of it; but as there are several Sorts of Cranes, and as that Machine is to serve for different Purposes, I wou'd only shew what kind of Crane is most proper for any particular Work; and how to prevent those Accidents which daily happen through the Carelessness of common Labourers, to the damaging of Goods, and often the wounding, or killing of the Men.

When great Weights are to be rais'd from a great Depth, and laid on Carriages very near the Precipice, as at the Edge of a Stone Quarry, the Crane must be a fix'd one, and only the Gibbet moveable, from which the Weight hangs, as in *Fig. 1*. Here, in the common Way, the Rope *R r r*, or Chain, which runs over the Gibbet, goes between two Pullies *P, Q*, fixed within the upper horizontal Beam of the Crane *A Q T X*, above the Axis of the Gibbet *B G V*, so as to be carried easily to the Right or Left Hand, from *W* to *w*, when the Gibbet turns upon its Axis to bring the Burthen over the Carriage design'd to receive

ceive it. For this Purpose, a small Rope, call'd the Guide-Rope, is fasten'd to the Weight, or to the upper Part of the Gibbet near its Extremity, *g*, which a Man is to pull to bring the Weight over the Place, to which it must be lower'd. Now in performing this, the main Rope or Chain not continuing parallel to the Arm of the Gibbet, gives the Weight a Tendency towards that Side to which it deviates, and that sometimes so suddenly, that without Care, and much Force applied, if the Weight be very great, the Burthen will swing to or from the Carriage, so as to break every thing in its Way. Sometimes an horizontal Piece, like an Handspike, is fix'd in the upright Shaft of the Gibbet a little above *B*, to turn it by; but in that Case too the Force is unequal, as the Weight is carried round; so that the Lives of the Men that are Loading, often depend upon the Care of the Man who guides the Weight, by either of the Means above-mentioned.

N. B. No Situation of the Pullies can prevent this; and we find Accidents to happen every Day, as will appear by the Examination of *Fig. 3*.

But if upon the Axis of the Gibbet there be fix'd an Iron Wheel, *y*, with many Teeth, to be carried round by a Pinion, *u*, of a few Leaves, upon the End of whose Axis is fasten'd a Wheel, *x*, with Arms (that Axis going through the perpendicular Piece *TZ* behind the Shaft of the Gibbet) a Man standing at that Wheel is out of Harm's Way, and has such an Advantage of Power as to hold the Weight steady in any Place requir'd, notwithstanding its Tendency to swing, as mention'd above, which is not felt at the Ends of the Arms of this last Wheel.

The first who has made Use of this Contrivance is Mr. *Ralph Allen*, Post-master of *Bath*, at his Stone-Quarry, where the Weight rais'd is 4 or 5, and sometimes 6 or 7 Ton.

I need not say that the Power to bring up the Weight works here by Means of a Capstane, or upright Shaft, R O, drawn round by Horses, that the Weight may come up more expeditiously, though in the Figure the Handspikes, *f, e, b*, going in at such an Hole as *d*, shew that Men may work it upon Occasion.

The same Gentleman having laid his Stone on Waggon of a peculiar Make, causes it to run down Hill about a Mile and an half, on a wooden Waggon-way (which I shall hereafter describe with the Waggon, when I shew the Society the Models, which are now making) to the River-side, where he has a Wharf, and there by another Crane exactly suited to the Work, he takes the Stone from the Carriages, and with great Expedition lets it down into the Barges or Vessels that come to fetch it.

In describing this Crane of Mr. *Allen's*, I shall shew how Accidents are prevented in this Manner of working.

This Crane is of the Sort which is commonly call'd a *Rat's Tail Crane*, Fig. 7. moving round a strong Post like a Wind-mill, so that it may turn quite round with all its Load. The Axel Bb, on which the Rope winds, is here horizontal like a Winch; but to gain Strength, instead of the walking Wheel C A, it is carried round by a strong Wheel and Pinion, Fig. 5 and 6; or is in Effect a double Axis in Peritrochio. Now in the common Cranes of this Kind, there

there is only a Catch (as EKA, *Fig. 5.*) to hold the Burthen at the Height it is brought up to, whilst the Crane is turn'd round in order to have the Weight lower'd into the Vessels, which is done by lifting up the Catch, and being ready to let it down again as Need requires. Sometimes an half Circumference of Wood (DIIB, *Fig. 5.*) is held hard against a wooden Wheel Ww, on the Axel, to regulate and govern the Descent of the Weight. But as in either of these Cases, if the Man at the Crane is careless, very bad Accidents happen, Mr. *Padmore*, Mr. *Allen's* chief Work-man, has made such a Contrivance, that the Pall or Lever whereby the Axel is press'd to direct the descending Motion, does so communicate with the Catch, that in Case the Man that ought to manage it, shou'd carelessly let it go, the Catch always takes, and thereby all Accidents are prevented; as will be shewn in the Explanation of the 5th and 6th Figures.

Where Goods are to be rais'd high, as in unloading Vessels, and also to be let down deep, as in loading them; (that is, where both the former Operations are to be perform'd) if the Weights do not exceed two or three Ton, and many Hands are not to be had, then an endless Screw turn'd by an Handle at each End (in an opposite Situation, or with one Handle and a Balance to it) leading an Axis in Peritrochio, or as it is commonly call'd, a Worm and Wheel applied to a Crane, with a Gibbet, is most useful: For the Teeth of the Wheel are pull'd by the Weight so directly against the Thread of the Worm in its Endeavour to descend, that one may leave the Handle in any Position where it will stop, with-

out

out any Catch, or the least Danger of the Weight falling back again.

But then, if you wou'd have the Weight to be let down, to descend pretty quick, which cannot be perform'd by applying the Hand to the Handle, which goes through a great Space in Comparifon to the Space describ'd by the Weight (without which fufficient Force would be wanting) only give the Handle a Swing, and if the Worm be well oil'd, the Handle and its Counterpoife, or the two Handles, will perform the Office of a Fly in the common Jack, turning very faft round, and regulating the Motion of the Weight, which from that Impulfe will defcend continually, and not too faft, like the Weight of a Jack.

The Way to ftop this Motion at any Time, is to grafp the Axis of the Screw hard, betwixt the Screw and the Handle in its round Part. The Hand is fufficient to do it, and will ftop it in two or three Turns.

N. B. *Such a Crane may be feen at Mr. Gray's, who makes them to fell, at Mill-Bank, Weftminfter.*

The worft Cranes are thofe where Men walk in a large Wheel, by reafon of Accidents that happen daily on account of the fhort Space between a Man's two Feet. This may be prevented by uſing four footed Animals, the Length of whoſe Bodies makes a Baſe of fufficient Length to keep the Wheel from running back, *Fig. 7.*

An Explanation of the Figures.

Fig. 1. Representing a fix'd Crane with a Gibbet moving on an upright Shaft or Axis.

A *a* Q, The Roof of the Crane to preserve the Rope R T *r* from the Weather, when the Arm of the Gibbet V G *g* being turn'd towards Y is brought under it.

A T, The upper Piece of the Crane, is an horizontal Situation, call'd *the Plate of the Crane*.

X, Y, Z, The three Crane Posts brac'd at Top and Bottom.

D S, M N, I E, Three Cills within the Stone Work, brac'd with Wood, and made fast with an upright Plate of Iron pinn'd to the Wood on each Side.

N. B. *When the Crane is not in Stone Work, the three Cills must be all in one Piece, reaching from D to E.*

H I, h E, Are the Braces of the main Post of the Crane, which come up above the Level of the Wharf L *w* B, which are longer and stronger than the others. Here a cross Piece whose Section is (&) keeps the main Post from twisting.

R O, The Capstane, or Shaft of the Crane to receive the Rope or Chain; which Shaft is turn'd here by Bars or Handspikes, such as *b d*, *f d*, or *e d*, the lower Part being strengthened with Iron Hoops above and below the Holes at *d*, with a Pivot or Iron Axis turning in an Hole in a Piece whose Section is F.

p p, Are two Pins, which hold on a Collar in which the upper Part of the Shaft turns.

CB,

C B, The Shaft or Axel of the Gibbet with Pivots and Iron Hoops at Top and Bottom, and a Wheel of Iron, *y*, having Teeth perpendicular to its Plane. This Wheel is led by a Pinion, *u*, which is on the Axis of the Wheel *x*, by whose Arms a Man standing at H may bring about the End of the Gibbet *g* with the Ram-head *r*, and the Weight hanging at it, either to the Right or Left, and easily hold the Gibbet in any Position.

CTPQ, A strong Piece or Block having three Pullies, one vertical, and the other two horizontal, that the Rope may run over the First of them, and between the two others.

Fig. 2. Represents an horizontal Section of the Crane in its upper Part, or rather a View of it from the Plane of the Roof, supposing the Roof taken off.

N. B. *The same Letters mark the Parts which have been described in Figure 1.*

Fig. 3. Shew the Inconveniencies in the Motion of the Gibbet.

L B E D, Represents Part of the Wharf next the Water, or Precipice of a Quarry.

T P Q, The Block-Piece which holds the three Pullies, expres'd by the same Letters in *Fig. 1* and *2*.

s g r G, The Arm of the Gibbet represented by V g, *Fig. 1*.

T, The vertical Pulley.

P, Q, The horizontal Pullies, represented in another Situation by *p, q*, when their Centers from *m, y*, are brought to *n* and *t*.

C, Is a Point directly over the Pivot of the Shaft, or Axel of the Gibbet.

C 1, C 2, C 3, C 4, C 5, Represents a Line over the Arm of the Gibbet, or rather a Plane going through the Middle of it, in several of its Situations, when turn'd towards the right Hand, from its direct Position C r.

C 6, C 7, C 8, C c, Represent the several Situations of the Gibbet towards the Left, the last Pulley r, at the End of the Gibbet, immediately over the Weight traversing in the Circle 5, 4, 3, 2, 1, 6, 7, 8.

When the Gibbet is in the Position c g, the Rope runs directly over the Middle of its Arm, therefore the least Force applied to r or r, can keep in its Place the greatest Weight that can be drawn up by the Crane, when suspended to the Ram-head. If the Pullies are at p and q, the Gibbet loaded will also be without Labour retain'd in the Position C 2 on the Right, and C 6 on the Left, and with no great Trouble in the Position C r.

But if the Gibbet be brought over the Wharf at 4 on the Right, or at 8 on the Left, the Rope will no longer run over the Middle of the Gibbet, but deviate from it, so as to make with it the Angle q 4 t, or o 8 n, and raise the Weight by the Motion of the Gibbet in Proportion as the Line q 4, or o 8, is longer than t 4, or n 8; and therefore the Weight will tend to run back towards g in Proportion to the Difference of those Lines, which must give a Twitch to the Person who draws from r, or r by a guide Rope.

If to prevent this Inconveniency the Pulley at q be remov'd back to Q, then indeed the Rope will run over the Line C 4, or t 4, and consequently the Gibbet will be easily held in that Situation; but if you have Occasion to move the Weight to 5, the Rope

E e

touching

touching the Pulley at t , will make an Angle with $C5$, and again be subject to the Inconveniency above-mentioned. Besides, in bringing the End of the Gibbet from g to 4 , the Rope immediately applying itself to the Pulley at t will come forward with a Jerk, though it will be twitch'd back again when at 5 .

If the Pulley be set backwarder still, as may be seen at P , when you wou'd keep the Weight under 8 , it will tend to go on towards c , in Proportion as the Rope at $m8$ is now shorter than the Line $n8$; for now the Weight descending a little, the Force of that Descent added to the Pull of him who draws the Guide Rope, will cause the Weight to swing towards the Crane, so as sometimes to do Mischief, if the Weight be very great, and the Men careless.

N. B. No Position of the Pulleys can mend the Matter, there being only three Situations of the Gibbet in its whole Traverse, where it can keep its Place when loaded. Therefore the Wheel, y , and the Wheel and Pinion, xu , in *Fig. 1.* are of very considerable Use when great Weights are rais'd.

Fig. 4. Represents the double Axis in Peritrochio, or Wheel and Pinion us'd instead of the walking Wheel of *Fig. 7.*

c, c , An Axis with Handles having a Pinion P which leads the Wheel PR to wind the Rope RZ on the Axel R .

K, A , Part of the Catch which stops the Rope from running back again.

Ww , A wooden Wheel of some Thickness, which (when the Catch is up) is kept from turning too swift as the Weight runs down, by pulling up the Semi-circular Part of the Ball $l o l$ so as to make it bear hard

hard against the Wheel below, to regulate or stop the Descent of the Weight.

C C, The Pivots or Centers of the Axel.

L F, Part of the Leaver, whereby the Pall is drawn up against the Wheel W w, by means of the Rope F B.

Q, The Weight to bring down the Pall clear of the Wheel W w, when it is not pull'd up.

I o I B, The End of the Pall which is applied to the Wheel, the other End not being represented here.

Fig. 5. Shews the Manner of letting down the Weight swifter or slower as there is Occasion, representing that End of the Axel on which the Catch and Pall act alternately.

P P and *pp* are two upright Pieces fix'd to the Frame of the Crane, in any manner that is most convenient for carrying the three Centers L, K, and *k*.

When the Rope R r Z going over a Pulley at *r*, or any where else, draws from the Axel in the Direction R r; the Catch, if its End is at A, keeps it immovable. But by pulling at H, the Leaver G F rises at F, and consequently draws up the End B of the Pall B D; which moving on the Center *k*, does by its End D (by means of the Bar D E) pull down E, and raise A of the Catch, so as to let the Rope run down; but to prevent its running too fast, one must pull a little harder; then the Semicircle I o I will press against the Wheel, and slacken the Descent of the Weight; which will be wholly stopp'd by pulling still harder: Then the Leaver, Pall, and Catch will be in the Position mark'd by prick'd Lines and small Letters. Now if the Person holding H, shou'd carelessly let it go, the Weight Q in descending will bring down the Pall at B, and

raise its other End, so as to throw the Catch in again upon the Teeth of the Ratchet, and stop the whole Motion without Accidents.

The 6th Figure represents the Wheel and Pinion at the other End of the Axis, where the same Letters express the same Parts.

The 7th Figure represents the Crane with the walking Wheel, the whole turning round upon the strong Post or Puncheon S, which is fix'd steadily upright by Means of the Braces and Gills L L L L L L L L; and when the Wheel and Pinion is us'd instead of the walking Wheel, all the other Parts are the same.

f F, Is a Brace and Ladder.

E, N, M, F, Pulleys for the Rope to run over, and come to the Weight at H.

N. B. Sometimes a Pair of Blocks is applied between F and H. A small wooden Roof also is applied over the Ends of the Pieces at E, N, M, and F.

V. Of the Meteor called the *Ighis Fatuus*, from Observations made in England, by the Reverend Mr. W. Derham, F. R. S. and others in Italy, communicated by Sir Tho. Derham, Bart. F. R. S.

IT being the Opinion of divers skillful Naturalists (particularly Mr. Fr. Willughby and Mr. Ray) that the *Ighis Fatui* are only the shining of a great Number of the *Male-Glowworms* in England, or of the *Pyraustis* in Italy, flying together, I was mind-

ed to consult my curious and ingenious Friend, Sir *Tho. Dereham*, about the *Phænomenon*, being informed, that those *Ignes Fatui* are common in all the *Italian* Parts. But of the *Pyraustæ*, or *Fire-flies*, he saith, *He never observed any such Effects, although there is an immense Number of them in June and July.* He saith moreover, that these *Pyraustæ* are called *Lucciole*, i. e. *Small Lights*, and that they are not the *Farfalls* (as *Mr. Ray* thought) which are *Butter-flies*.

But I have good Reason to think, that Insects are not concerned in the *Ignes Fatui*, from the following Observations; the First of which I made my self, and the others I received from *Italy*, by the Favour of Sir *Tho. Dereham*.

My own Observation I made at a Place that lay in a Valley between Rocky Hills, which I suspect might contain Minerals, in some Boggy Ground near the Bottom of those Hills. Where, seeing one in a calm, dark Night, with gentle Approaches I got up by Degrees within two or three Yards of it, and viewed it with all the Care I possibly could. I found it frisking about a dead Thistle growing in the Field, until a small Motion of the Air (even such as was caused only by the Approximation of my self) made it skip to another Place, and thence to another, and another.

It is now about fifty-five Years since I saw this *Phænomenon*, but I have as fresh and perfect an Idea of it, as if it was but of a few Days. And as I took it then, so I am of the same Opinion now, that it was a *fired Vapour*.

The *Male-Glowworms* I know emit their shining Light, as they fly; by which Means they discover
and

and woo the Females : but I never observed them to fly together in so great Numbers, as to make a Light equal to an *Ignis Fatuus*. And I was so near, that had it been the Shining of Glowworms, I must have seen it in little distinct Spots of Light ; but it was one continuous Body of Light.

Having thus related my own Observations of the *Ignes Fatui*, I shall next give an Account of the Observations which Sir *Tho. Dereham* procured for me in *Italy*, in the following Letter of Dr. *Giacomo Bartholomeo Beccari*, F. R. S. to Sir *T. Dereham*, F. R. S. dated at *Bologna*, Octob. 23, 1728, and translated from the *Italian*, by the late Dr. *Joh. Caspar Scheuchzer*. Which Letter is in these Words.

TIS purely in Obedience to your Commands, by Dr. *Eustachio Manfredi*, I send you the following Observations on the *Ignes Fatui*. What I am now going to offer to you concerning these fiery Appearances, is the Result of several Conversations I had upon this Subject with several experienced Travellers, Men of Learning and Reputation, whose Sincerity I had no Reason to mistrust. For my own farther Satisfaction, ever since I received your Commands, I have made it my Business to speak with as many as I could light of, with such as travelled much in the Mountains, and with others that observed them in Plains, on Purpose to see whether or no the Difference of the Place made any sensible Difference in the Appearance. I find upon the Whole, that they are pretty common in all the Territory of *Bologna*. To begin with the Plains, they are very frequently observed there; the Country People

ple call them *Cularfi*, perhaps from some fancied Similitude to those Birds, and because they look upon them as Birds, the Belly and other Parts of which are resplendent like our shining Flies. They are most frequent in watry and morassy Ground, and there are some such Places, where one may be almost sure of seeing them every Night, if it be dark. In the Fields near the Bridge *Della Calcarata*, in a Common belonging to the Parish of *S. Maria in dono*, North of *Bologna*, one of these fiery Appearances is very often observed to move a-cross the Fields, coming from another Bridge, called *Della Fossa quadra*. There is another of them in the Fields of *Bagnara*, almost East of *Bologna*, which scarce ever fails to appear in dark Nights, particularly when it rains, or snows, as also in cold and frosty Weather. Both these, I mean that near the Bridge of *Calcarata*, and that in the Fields of *Bagnara*, are very large; and I am assured, that sometimes their Light is equal to that of one of our ordinary Faggots or Bundles made of Branches of Vines, and that it is scarce ever less than that of the Links which our Country People make of Hemp-stalks, and which they light themselves withal, when they travel at Night. That at *Bagnara* appeared, not long since, to a Gentleman of my Acquaintance, as he was travelling that Way; it kept him Company for a Mile or better, constantly moving before him, and casting a stronger Light on the Road, than the Link he had with him.

I believe there may be many more in other Plains as large as these two, though at present I have not been able to get certain Information of any others. Lesser ones there appear a good many, some of them
giving

giving as much Light as a lighted Torch, and some there are no bigger than the Flame of a common Candle. Of these, I have been assured, a good many were seen in the Fields of *Barijella*. All of them have the same Property in resembling both in Colour and Light, a Flame strong enough to reflect a Lustre upon Neighbouring Objects all round. They are continually in Motion, but this Motion is various and uncertain. Sometimes they rise up, at others they sink. Sometimes they disappear of a sudden, and appear again in an Instant in some other Place. Commonly they keep hovering about six Foot from the Ground. As they differ in Largeness, so they do in Figure, spreading sometimes pretty wide, and then again contracting themselves. Sometimes breaking to all Appearance into two, and a very little while after meeting again into one Body; sometimes floating like Waves, and letting drop some Parts like Sparks out of a Fire. I have been assured, that there is no dark Night all the Year round, when they do not appear. And in the very Middle of the Winter, when the Weather is very cold, and the Ground covered with Snow, they are observed more frequently than in the hottest Summer. The Gentleman who obliged me with an Account of that at *Bagnara*, told me, that if I had a Mind to see it my self, I might be sure of finding it if I went thither in very cold Weather, and in a sharp Frost. Nor doth either Rain or Snow in any wise prevent or hinder their Appearance; on the Contrary, they are more frequently observed, and cast a stronger Light in rainy and wet Weather. This last Circumstance indeed hath been taken Notice of by some Writers, and
among

among the rest, if I remember right, by the learned *Gassendi*. Neither doth the Wind much hurt them, though one should think, that if it was a burning Substance, like common Fire, it should either be dissipated in windy Weather, or extinguished by Rain. But since they do not receive any Damage from wet Weather, and since, on the other Hand, it hath never been observed, that any thing was thereby set on Fire, though they must needs in their moving to and fro, meet with a good many combustible Substances, it may from thence be very reasonably inferr'd, that they have some Resemblance to that Sort of Phosphorus which doth indeed shine in the Dark, but doth not burn any thing as common Fire doth. Nor is there any thing extraordinary in this, any more than in other fiery Appearances, which I am informed are likewise pretty common, and agree with the *Ignes Fatui*, in having only the Splendor and Appearance of Fire, without the Quality of Burning, but differ from them in a good many other Particulars. Such a Phænomenon was observed by a noted Clergy-man of this City, one Summer's Evening, near some Country Peoples Houses. The Flame seem'd to him so strong, that he called to them to put it out, for fear it should reach a Hay-loft, and a Heap of Hemp that lay not far from it; but when he came to the very Place where he had first seen the Flame, he perceived that it was only an Appearance, observing not the least Footstep of Fire, though he assured me there lay a good deal of combustible Stuff all thereabouts, which would have easily took Fire, if there had been any thing of an actual Flame upon the Spot. The same Gentleman told me, that in a

very dry Summer (I do not know whether the same with the foregoing) he observed, in the Middle of some other Fields of his own, for several Evenings together, a pretty considerable Flame on the Ground, nearly in the same Place, and that having resolved to go and take a nearer View of it the next Evening, it did not appear for that Time; that, however, he went to the Place where he had before seen it, and sat himself down on the Ground, but could not observe the least Mark of any Fire or Flame having been in that Spot, nor feel any Heat in the Ground any more than in other Places; only he saw some slight Flames arising out of the Ground hard by, which disappeared as soon as they came into the open Air. It is well known to People that travel on Horseback at the Beginning of the Night, in the Heat of the Summer, when they traverse the dry Beds of Rivers, and break with their Horses Feet those sandy Grounds that have been all Day long strongly heated by the Sun, there rise up some bluish Flames, which very often fright the Horses. This Phenomenon is most common in those Places where the Water hath left behind a kind of a chalky Sediment, or fat Earth, which drying, afterwards forms a thick hard Crust. So likewise if in the Heat of the Summer you travel in dark Nights, either on Horseback, or on Foot, over the burnt-up Ground of some Fields, you shall see Flames break out of the Ground almost at every Step. All these Fires and Flames have indeed the Light and Shining, but not the Burning Quality of Fire, whether from the extream Smallness and Rarity of their Parts, as some apprehend, or for some other Reason, I will not attempt to determine. And this is the only Thing they

they have in common with the *Ignes Fatui*, differing very much in other Respects, particularly in not appearing at all Seasons of the Year, and most frequently in the Winter, as the others do. Thus far, what I could learn concerning the *Will with a Wisp*, as it hath been observed in the Plains. As to the Appearance of this Phenomenon in mountainous Parts, by what I have hitherto been able to learn, they differ in nothing else but in Largeness; and all those I conversed with, that saw them in the Mountains, agree in that they never observed any larger than the Flame of an ordinary Candle. Nor do those that live in the Mountains call them *Culars*, which Name is perhaps used only by the Country People in the Plains for those large ones above described. I will make it my Business to enquire a little farther into this Matter, if perhaps the large ones are seen in the Plains only, and those in the Mountains are always small. The Difference of the Air, and that of the Soil may, for ought I know, contribute a great deal towards the different Size of these Appearances; at least all that I can offer material at present towards solving this particular Circumstance, with Regard to their Largeness, is, that those Grounds, where we observe the largest Fires, as at *Bagnara*, are what they here call *strong Ground* (*terreni forti*) being a hard chalky and clayey Soil, which will harbour the Water a long while, and is afterwards, in hot Weather, very apt to break into large Cracks and Fissures; whereas on the contrary, those Soils in the Mountains, where they observe the small Fires, are what they call soft, or *sweet Ground* (*terreni dolci*) being generally sandy, and of a more loose Contexture, which do not

keep the Water so long as the others. Of that Sort also is the Soil in the abovementioned Plains of *Bari-Jella*, where, about seven or eight Years since, they observed a good Number of the smallest *Ignes Fatui* in the Fields, within the Compass of about three Miles. One Thing I will beg Leave to add, that according to the best Informations I have hitherto been able to procure, these Lights are great Friends to Brooks and Rivers, being frequently observed along the Banks of them, perhaps because the Air carries them thither more easily than any where else. In all other Particulars, as in their Motion, the Manner of their Appearance, their disappearing sometimes very suddenly, their Light, the Height they rise to, and their not being affected either by rainy or cold Weather, they are the very same with the *Cularsi* above described, or the large *Will with a Wisp*, as observed in the Plains.

I intended here to have closed this Account, but I cannot forbear adding the following Observation, which in my Opinion is very curious and singular. I am indebted for it to a young Gentleman, a very accurate and knowing Observer of natural Appearances. Travelling sometime in *March* last, between eight and nine in the Evening, in a mountainous Road not far from our *Lady del Sarso*, about ten Miles South of *Bologna*, as he approached a certain River called *Rioverde*, he perceived a Light, which shone very strongly upon some Stones that lay upon the Banks. It seemed to be about two Foot above the Stones, and not far from the Water of the River. In Figure and Largeness it had (the Appearance) of a *Will with a Wisp*, somewhat above a *Bolognese* Foot in Length, and about

about half a Foot high, its longest Side lying parallel to the Horizon: Its Light was very strong, inasmuch that he could very plainly distinguish by it Part of a neighbouring Hedge, and the Water in the River; only in the East Corner of it the Light was pretty faint, and the square Figure less perfect, as if cut off, or darkened by the Segment of a Circle. The Gentleman's Curiosity tempted him to examine it a little nearer; in order to which he advanced gently towards the Place, but was surprized to find that it

and then ~~it~~ ~~disappeared~~, in proportion as he drew nearer, and that when he came to the Place it self, it was quite vanished. Upon this he stepp'd back, and not only saw it again, but found that the farther he went from it, the stronger and brighter it grew; nor could he upon narrowly viewing the Place where this fiery Appearance was, perceive the least Blackness, or Smell, or any Mark of an actual Fire. The same Observation was confirm'd to me by another Gentleman, who frequently travels that Way, and who assured me, that he had seen the very same Light five or six different Times, in *Spring* and *Autumn*, and that he had always observed it in the very same Shape and the same Place, which to me seems very difficult to be accounted for. He told me farther, that once he took particular Notice of its coming out of a neighbouring Place, and then settling it self into the Figure above described. How it comes to pass, that the nearer one approaches to these, or the like fiery Appearances, the fainter they grow, till at last they disappear totally, I very freely own my self at a Loss, but yet I cannot help thinking, that there is something

thing in it analogous to what we observe in Fogs and Clouds, which at a Distance have indeed the Appearance of very thick Bodies, but are found more rare as one gets into them. Nor is it improbable, as they must be something very thin and subtle, that upon the Approach of grosser Bodies with their Atmospheres, they are actually driven away.

This is the Substance of what I have been able to gather from several Accounts relating to the *Ignes Fatui*; but as to the Causes of them, I will not pretend to assign any: I will only add, that all that ever saw any of these fiery Appearances agree, and you may assure Mr. *Derham* of it, that they cast a Light quite different from that of the *shining Flies*; and if you please to reflect on the several Circumstances above related, I believe you will find, that they are not easily, if at all, to be solved by that Hypothesis. I intend in another Letter to trouble you with some Questions, and likewise some Observations of my own on *these Flies*, mean while,

I am, &c.

VI. *Duæ Observationes Eclipsis Lunæ Totalis Noctē
sequente Diem 28 Julij 1729. S. V. Communi-
cante Cl. Thomâ Dereham, Bart. & R. S. S.*

*Observatio in publico Observatio Bononiæ facta.
à Dno. Eustachio Manfredi, M. D. R. S. S. &c.*

Temp. Ver.

H. ' "

11	56	52	E Clipsis certè incepta.
12	11	33	E Initium <i>Copernici</i> .
12	56		{ Centrum <i>Copernici</i> , sed ex alterâ Deter- minatione 2" citiùs.
19	46		{ Initium <i>Tychonis</i> , sed ex alterâ Deter- minat. 2" citiùs.
20	54		Medium <i>Tychonis</i> .
21	43		Totum <i>Tychonem</i> .
23	43		Initium <i>Platonis</i> .
24	42		Medium <i>Platonis</i> .
25	23		Totum <i>Platonem</i> .
25	55		<i>Insula in Sinu medio</i> .
27	35		Totum <i>Manilium</i> .
29	35		Totum <i>Aristotelem</i> .
32	7		Totum <i>Menelaum</i> .
35	0		Totum <i>Plinium</i> .
38	49		<i>Promontorium somni</i> .
39	26		<i>Promontorium acutum</i> .
44	16		Totum <i>Fracaſtorium</i> .
45	42		Totum <i>Proclum</i> .
46	59		Initium <i>Maris Crisum</i> .

Medium

Temp. Ver.

H. 1 "

			{ Medium <i>Maris Crispi</i> , sed ex alterâ
12	49	47	{ Determinat. 1 ^a citius.
	52	19	Totum <i>Mare Crispum</i> .
	53	6	Totum <i>Pelagicum</i> .
12	55	54	Totalis Immerfio Lunæ.
14	34	25	Initium Emerfionis dub.
	37	30	Initium <i>Grimaldi</i> .
	38	20	Totum <i>Galileum</i> .
	38	28	Totum <i>Grimaldum</i> .
	39	45	Totum <i>Aristarchum</i> .
	44	47	Totum <i>Keplerum</i> .
	48	33	Initium <i>Platonis</i> .
	49	37	Medium <i>Platonis</i> .
	50	42	Totum <i>Platonem</i> .
	52	47	Totum <i>Copernicum</i> .
	55	32	Totum <i>Bullialdum</i> .
15	1	56	Initium <i>Tychonis</i> .
	2	36	Medium <i>Tychonis</i> .
	3	50	Totum <i>Tychonem</i> .
	4	50	Totum <i>Manilium</i> .
	7	47	Totum <i>Menelaum</i> .
	11	2	Totum <i>Dyonifum</i> .
	11	37	Totum <i>Plinium</i> .
	18	53	<i>Promontorium acutum</i> .
	20	30	Initium <i>Maris Crispi</i> .
	20	59	Totum <i>Proclum</i> .
	23	34	Medium <i>Maris Crispi</i> .
15	35	00	Finis Eclipsis.

Observatio Eclipsis Lunaris in Collegio Romano Societatis Jesu, t. p. m. n.

Immerfiones.		H.	l.	"
Umbra ad	limbum	— — — —	12	01 00
<i>Kepleri,</i>	{ Initium	— — — —		07 49
	{ Medium	— — — —		09 04
	{ Finis	— — — —		09 50
<i>Copernici,</i>	{ Initium	— — — —		15 00
	{ Medium	— — — —		16 26
	{ Finis	— — — —		17 00
<i>Heraclidis,</i>	{ Initium	— — — —		17 11
	{ Medium	— — — —		17 27
	{ Finis	— — — —		17 40
<i>Heliconis,</i>	{ Initium	— — — —		22 26
	{ Medium	— — — —		22 41
	{ Finis	— — — —		23 07
<i>Tychonis,</i>	{ Initium	— — — —		23 50
	{ Medium	— — — —		24 41
	{ Finis	— — — —		25 25
<i>Platonis,</i>	{ Initium	— — — —		28 43
	{ Medium	— — — —		29 14
	{ Finis	— — — —		29 50
	{ Initium	— — — —		31 05
	{ Medium	— — — —		32 00
	{ Finis	— — — —		32 45
<i>Menelai,</i>	{ Initium	— — — —		35 04
	{ Medium	— — — —		35 45
	{ Finis	— — — —		36 08
<i>Maris Crisum.</i>	{ Initium	— — — —		51 37
	{ Medium	— — — —		54 10
	{ Finis	— — — —		56 08
Totalis Immerfio		— — — —	13	00 16

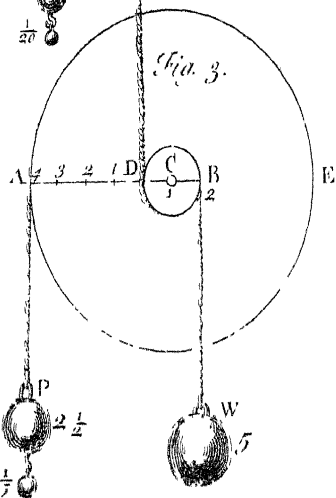
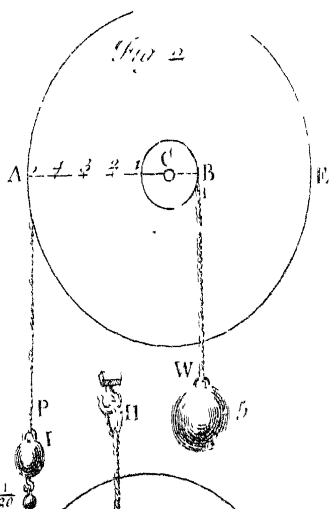
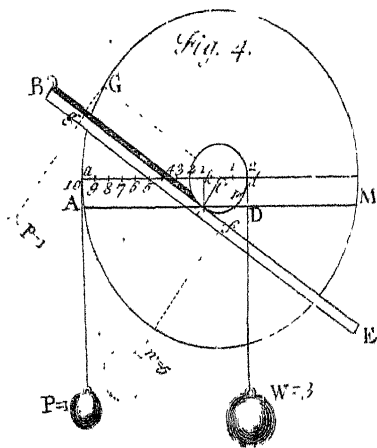
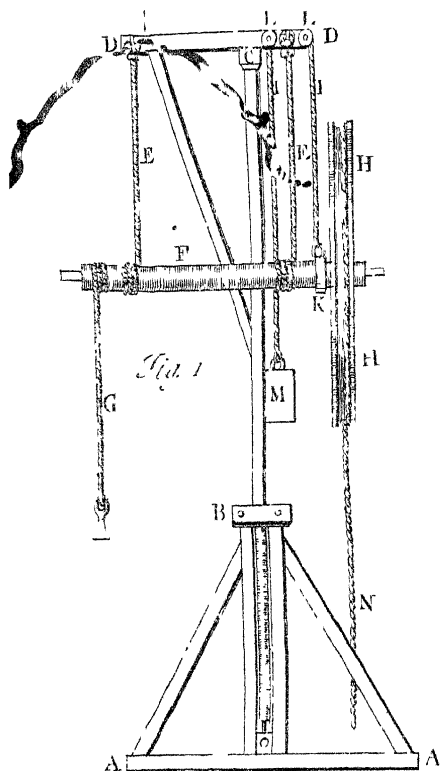
	Emerfiones.	H.	'	"
Lux ad ☉ limbum — — — — —		14	38	24
Grimaldi Finis — — — — —			43	24
Kepleri Finis — — — — —			44	34
<i>Heraclidis,</i>	{ Initium — — — — —		46	14
	{ Medium — — — — —		46	54
	{ Finis — — — — —		47	24
<i>Heliconis,</i>	{ Initium — — — — —		49	10
	{ Medium — — — — —		50	04
	{ Finis — — — — —		50	44
<i>Platonis,</i>	{ Initium — — — — —		51	24
	{ Medium — — — — —		52	09
	{ Finis — — — — —		52	44
<i>Tychonis,</i>	{ Initium — — — — —	15	07	05
	{ Medium — — — — —		07	13
	{ Finis — — — — —		08	18
<i>Maris Crisum,</i>	{ Initium — — — — —		26	39
	{ Medium — — — — —		28	38
	{ Finis — — — — —		31	51
Totalis emerfio — — — — —			38	00

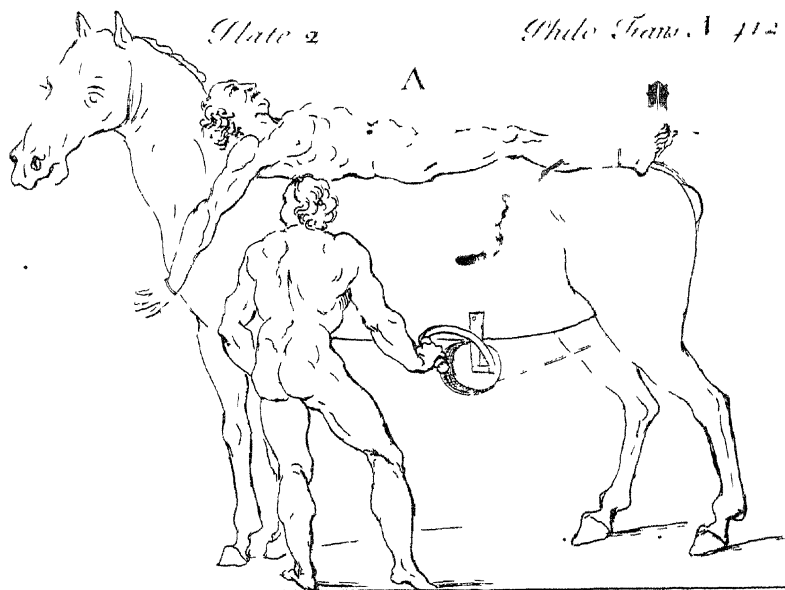
Observationes habitæ sunt telescopiis pedum Romanorum 9, aere innubi, sed vaporoso ita, ut circa Eclipsis finem limbus Lunarîs tremere videretur. Diameter Lunæ horizontalis capta 15 h. 46' intercipiebat micrometri partes 2934, quarum verticalis Lunæ diameter comprehendebat 2877, at Solis diameter die præcedenti viſa eſt occupare partes 2830.

	H.	'	"
Tempus Immerſionis — — — — —	59	16	
Tempus Emerſionis — — — — —	59	36	
Mora in tenebris — — — — —	1	38	08
Duratio Eclipſis — — — — —	3	37	00
Solis Meridiani refractione omniſ- ſæ tangentes in Gnomone, cujus	7	Auguſti	{ 48 190
aperturæ horizontalis diameter			{ 47 040
	8	Auguſti	{ 48 801
			{ 47 731

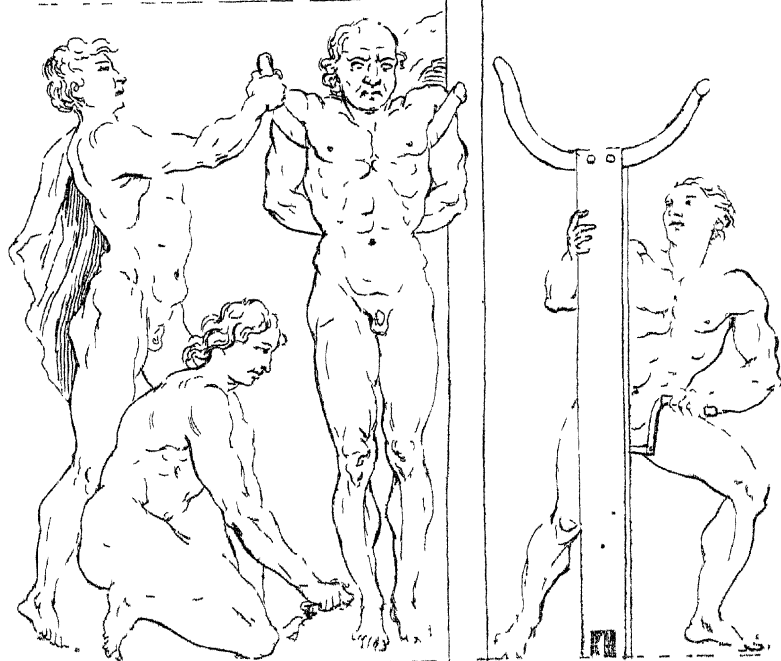
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B



PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *January* and *February*, 1730.

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- I. *A Catalogue of the fifty Plants from Chelsea-Garden, presented to the Royal Society, by the Company of Apothecaries, for the Year 1728; pursuant to the Direction of Sir Hans Sloane, Bart. Med. Reg. Præs. Col. Reg. Med. & Soc. Reg. By Isaac Rand, Apothecary, F. R. S.*
- II. *An Examination of Monsieur Perrault's new-invented Axis in Peritrochio, said to be entirely void of Friction: With an Experiment to confirm the Reasoning made upon an Axis in Peritrochio first us'd in Mons. Perrault's Manner, then in the common Way, by J. T. Desaguliers, L L. D.*

III. *A*

The CONTENTS.

III. *A farther Examination of the Machine said to be without Friction. By the same.*

IV. DE EQV VLEO: *Auctore Joanne Wardo, Rhet. Prof. Gresh. et R. S. S.*

V. *An Account of a Treatise entituled, Calculations and Tables relating to the attractive Virtue of Loadstones, &c. Printed Anno 1729.*

VI. *An Account of a Book entituled, Jo. Frider. Weidleri Observationes Meteorologicæ & Astronomicæ, Annorum 1728 & 1729, &c. Wittembergæ, Anno 1729.*

VII. *Occultatio Veneris à Lunâ subeunte Berolini visa die 19 Septembris, 1729, N. S. p.mer. à D. Kirchio. Ex Diario Meteorologico (M.S.) J. Fred. Weidleri, L. L. D. & Math. Prof. Prim. Wittembergæ.*

I. *A Ca-*

- I. *A Catalogue of the fifty Plants from Cheliea-Garden, presented to the Royal Society, by the Company of Apothecaries, for the Year 1728; pursuant to the Direction of Sir Hans Sloane, Bart. Med. Reg. Præs. Col. Reg. Med. & Soc. Reg. By Isaac Rand, Apothecary, F. R. S.*

301. **A**NONIS Americana; folio latiori, subrotundo. T. Inst. 409.
302. Apocynum frutescens; Salicis folio, angusto.
An Apocynum erectum, Africanum; Villoso fructu; Salicis folio, glabro, angusto. Par. Bat. 24?
303. After Americanus, serotinus, altissimus; folio brevi, caulem amplectente.
304. Betonica maxima; Scrophulariæ folio; flore e luteo pallefcente. Schol. Bot. 64.
305. Betonica maxima; Scrophulariæ folio; floribus incarnatis. Par. Bat. 106.
306. Chamædrys; vulgo vera existimata. J. B. 3. 288.
307. Chamædrys; foliis parvis levitè crenatis.
308. Chamædrys; frutescens; Teucrium vulgo. T. Inst. 205.
309. Chamædrys; laciniatis foliis. Lob. Icon. 385.
310. Chamædrys; quæ *Teucrium Hispanicum, supinum; Verbenæ tenuifoliæ foliis. D. Goiffon. D. Fussieu.*
311. Commelina graminca, latifolia; flore cæruleo. Plum. N. Gen. Plant.

312. *Conyza Orientalis*, humilis; *Verbasci folio*, candidissimo.
An Conyza tomentosa & candidissima; subrotundo, crasso folio; flore luteo. D. Sherard. Ac. Reg. Sc. Par. Anno 1719?
313. *Corona Solis*; *Trachelii folio*; radice repente.
T. Inst. 490.
314. *Corona Solis*; *Trachelii folio*, ramosior; radice non repente.
315. *Corona Solis*; *Trachelii folio*, tenuiore; calyce floris foliato.
316. *Cotinus coriaria*. *Dod. 780.*
317. *Doria major*, repens.
Virga aurea maxima; radice repente; sive Dorea major, repens. D. Bobart. Hist. Ox. 3. 123.
318. *Doria*; foliis tenuitèr ferratis, ad caulem latis.
An Alisma Monspeliensium; sive Doria. J. B. 2. 1064?
319. *Doria*; quæ *Jacobææ Orientalis*; *Limonii folio. T. Cor. 36.*
320. *Elatine*; folio acuminato in basi auriculato; flore luteo. *C. B. 253.*
321. *Elatine*; folio subrotundo. *Ib.*
322. *Elatine Hispanica*, rotundifolia; pediculis florum brevissimis. . .
323. *Ferrum equinum*, Germanicum; filiquis in summitate. *C. B. 349.*
324. *Geranium Ægyptiacum*; *Althææ folio*, subtùs glauco. *Lippii. D. Juslieu.*
325. *Geranium Alpinum*; *Coriandri folio*; longius radicatum; flore purpureo. *D. Micheli. Hort. Pisan. 68.*

326. *Hermannia frutescens* ; folio Ibis, luscuto, molli ;
caule piloso. Boerh. Ind. 1. 115.
327. *Hermannia* ; Alni folio parvo.
An Ketmia Africana, fruticans & cæstos
Alni foliis latioribus & majoribus ; per
Spirali Sulphureo. Hort. Amst. p. 2. 155 ?
328. *Hermannia* ; minimo Alni folio.
An Ketmia, &c. Foliis triplo minoribus. Ib.
329. *Jacobaea Hispanica*, minùs laciniata ; petalis brevissimis. T. Inst. 486.
330. *Jasminum Arabicum* ; Castaneæ folio ; flore albo, adoratissimo ; cujus fructus Coffy in officinis. Boerh. Ind. alt. 217. *Arbor Yemenis fructum Coffè ferens. D. Douglas.*
331. *Linaria vulgaris lutea* ; flore majore. C. B. 212.
332. *Linaria lutea elatior & ramosior* ; flore minori.
333. *Linaria, Hispanica*, procumbens ; foliis uncialibus, glaucis ; flore flavescente, pulchrè striato, labiis nigro-purpureis.
334. *Linaria multicaulis*, erecta annua ; angusto Moluginis folio ; floribus luteis rarè dispositis.
335. *Lactuca perennis*, humilior ; flore cœruleo. T. Inst. 473.
336. *Parietaria Officinarum & Dioscoridis*. C. B. 121
337. *Parietaria vulgaris, Anglica. Parietaria minor*
Ocimi folio. C. B. Ib.
338. *Partheniastrum Americanum* ; Ambrosiæ folio. Ac. Reg. Sc. Par.
339. *Ricinoides arbor, Americana* ; folio multifido. T. Inst. 656.
340. *Satureia montana*. C. B. 218.
341. *Satureia montana* ; latiori folio ; ramulis minùs erectis.

342. Sclarea, folio Salviæ, minor, five glabra. T. Inf. 180.
 343. Sclarea, folio triangulari; caule tomentoso. Ib.
 344. Tribulus terrestris. J. B. 2. 352.
 345. Tribulus terrestris, hexaphyllos, Americanus.
An Tribulus terrestris major; flore maximo, odorato. Sloan. Hist. Vol. I. p. 209. Tab. 132. Fig. 1?
 346. Trifolium, angustifolium spicatum. J. B. 2. 376.
 347. Trifolium arvense, humile, spicatum five Lagopus. C. B. 328. foliis latioribus. *Lagopodium Lagopus. Tab. Icon. 524.*
 348. Trifolium, Lagopus dictum, angustioribus foliis. *Lagopus Lob. Icon. 39.*
 349. Trifolium pratense, hirsutum, majus; flore albo Sulphureo. Raii Syn. Ed. 2. 193.
 350. Trifolium pratense, folliculatum. C. B. 329.

II. *An Examination of Monsieur Perault's new-invented Axis in Peritrochio, said to be entirely void of Friction: With an Experiment to confirm the Reasoning made upon an Axis in Peritrochio first us'd in Monsr. Perault's Manner, then in the common Way, by J. T. Desaguliers, L L. D.*

AS the Recommendation and Contrivance of a Person, who is considerable in mechanical Performances, is a great Inducement for others to make use of
 of

of a new Machine, which he affirms to have answer'd, in Practice, beyond any other us'd for the same Purpose; so I thought it wou'd be an Advantage to those who have Occasion for Machines, to shew the Imperfection of such an Engine, when the Author of it has been mistaken; thereby to prevent needless Expence and Disappointment, in erecting and trying such kind of Machines.

Monsieur *Perault's* Account of his Engine is as follows: " In Imitation of the (modern) Crane,
 " I have invented two Engines for raising Weights.
 " The first is made of that Organ which is the most advantageous of any in Mechanics, for facilitating Motion; because it is free from that Inconveniency which we meet with in all others; namely, the Friction of the Parts of the Machine, which renders their Motion more difficult. This Organ is the Roller, which *Aristotle* prefers to all other Organs, because all the others, as Wheels, Capstanes, and Pulleys, must necessarily rub in some of their Parts. But the Difficulty was to apply the Roller to an Engine that raises Weights, its Use having only been hitherto to cause them to roll on an horizontal Plane. The Engine which I propose has a Base A A B, (Plate I. Fig. 1.) something like the Crane: This Base has in its upper Part the horizontal Pieces B, which clasps an upright Shaft C O, supported under its Pivot C, on which the whole Engine moves in the same manner as the Crane, when the Weight is to be lower'd. This Shaft supports on its Top a cross Piece D D, to which are fasten'd the Ropes E E, which wrap round the Barrel, Axel, or Roller F, which has another Rope G, that also wraps or winds
 " round

“ round one of its Ends. F is Iust Rope is that which
 “ raises the Weight. At the other End of the Axel
 “ there is a great wooden Wheel like a Pully H H,
 “ about which is wound a long Rope N.

“ To work this Engine, one must pull the long Rope
 “ N, which causing the great Wheel to turn, does also
 “ carry round the Axel or Barrel, which is made fast
 “ to it. This Axel, as it turns round, causes the
 “ Ropes E E to wind about it, and thereby the Axel
 “ and the Wheel rise, whilst the Rope F, to which
 “ the Weight is fasten’d, does also wind itself up upon
 “ the Axel the contrary Way; and this double wind-
 “ ing up of the Ropes makes both the Burthen and
 “ the Axel and Wheel to rise at the same Time. Now
 “ it is evident, that all this Rise is perform’d without
 “ the Friction of any Part, and consequently, the whole
 “ Power which draws the Rope N, is employ’d with-
 “ out any Hindrance; which cannot be in other En-
 “ gines.

“ It may be objected that the Power which acts at
 “ N, must, besides the Weight, raise also the Axel and
 “ great Wheel, and that their Weight is one of those
 “ Obstacles which *Aristotle* says all Engines are lia-
 “ ble to; and that this Obstacle is equivalent to the
 “ Friction which is in other Organs. But it may be
 “ answer’d, That Friction is an Obstacle wholly una-
 “ voidable in all other Organs; but that it is easy to
 “ remedy the Obstacles of this, which is done by
 “ Means of the heavy Body M, taken equal in Weight
 “ to the great Wheel and Axel, which it sustains by
 “ Means of the Rope I I, which running over the
 “ Pullies L L, is fix’d to the Ring or Collar K, that
 “ goes round the Axel F. For the Axel and the
 “ Wheel

“ Wheel being counterpois’d by this Weight, the Power
 “ which act^s by drawing the long Rope N, acts for
 “ raising the Weight only. The Experiment which
 “ was made with this Engine has confirm’d the Truth
 “ of this Problem, by comparing its Effects with those
 “ of a Crane, in which the Proportion of the Bigness
 “ of the Axle to the Circumference of the Wheel,
 “ was the same as in my Machine : For it happen’d
 “ that in the Crane, a Weight of One hanging at a
 “ Rope going about the Wheel, drew up a Weight of
 “ Seven, when it had one Half added to it to make it
 “ preponderate, or give Motion to the Power : And
 “ when the Weight to be rais’d, and the Weight which
 “ serv’d as a Power, were proportionably encreas’d,
 “ there was also a Necessity to encrease the additional
 “ Weight, which made the Power preponderate, in the
 “ same Proportion : So that as it was requir’d to add
 “ one Half to the Power when the Weight was Seven ;
 “ the Addition to the Power became One for a Four-
 “ teen Pound Weight, Two for a Twenty-eight Pound,
 “ Four for a Fifty-six Pound, and so on ; because
 “ the Resistance from Friction encreases nearly in the
 “ same Proportion that the Weights are encreas’d.
 “ But this did not happen to my Engine, in which one
 “ Quarter was always sufficient for the Draught (or
 “ to make the Power preponderate) not only when
 “ the Weight was Seven, but also when it was Four-
 “ teen Pound, Twenty-eight Pound, Fifty-six Pound,
 “ &c. which evidently shews, that this Engine acts
 “ without Friction.”

Thus far *Monf. Perault*. But however plausible
 this Description may appear, a little Attention will
 shew, that if this new Engine had no Friction, yet it is

more

more inconvenient than an *Axis in Peritrochio* with the same Proportions; and likewise that it has more Friction than the same Machine in the common Use A C E, (Fig. 2.) is a common *Axis in Peritrochio*, which has the Wheel A E five Times bigger in Diameter than the Axle; so that A C, the Radius of the Wheel (which is the Distance of the Power) is to C B the Radius of the Axle (the Distance of the Weight) as 5 to 1: Consequently One (for Example one Ounce, as in our Experiment) will keep five in *Æquilibrium*. Now though the Friction of the Gudgeon at C is unavoidable, yet it may be diminish'd by diminishing the Diameter of the Gudgeon, provided it remains strong enough to sustain the Machine and its Burthen. Here one Penny-weight, or $\frac{1}{16}$ of the Power added to it, makes it preponderate, and give the Machine Motion with a due Velocity.

Now this very Engine made use of in Mons. *Perault's* Way, does so alter the Distances of the Weight and Power, that instead of One for our Power, we must have Two and a half to keep the very same Weight Five, in *Æquilibrium*, as may appear by a Sight of the third Figure, where, since in the Action of the Machine, when we pull the Rope P A, we make the Axle D B to wind itself up upon the Rope H D, it is evident that D is now become the Center of Motion, D B (the whole Thickness of the Axis) the Distance of the Weight = 2; and the Distance of the Power is reduc'd to A D = 4. So that if two Men, having been employ'd in the common Way to raise Weights equal to the Strength of ten Men, an Engineer should alter the Manner of working, and fit up the *Axis in Peritrochio* in Mons. *Perault's* Way, instead of gaining an

an Advantage, he must call in three more Men to perform the Work. If it be answer'd, that what is lost in Strength, will be gain'd in Time, it may not only be said, that one cannot always call in more Help on the sudden, but that even then, tho' we should not call this an Inconveniency, yet there will be still more Friction in this than in the common Method ; for the Roller or Axel will find a Difficulty to wind on the Ropes, because they are not perfectly pliable, and the less so, the greater the Weight is that stretches them. This, together with the Friction of the Collar of the Rope of the Counterpoise to the Engine, makes the Hindrance greater than in the common Way. For it appears by Experiment, that when the Power is become equal to $2\frac{1}{2}$ to keep the Weight 5 in *Æquilibrium*, there must be added $\frac{1}{5}$ (here 4 Penny-weight) to put the Power in Motion.

And to shew that this Friction of the Ropes is not always the same as *Monf. Perault* supposes it ; when P (or the Power) is made only one Ounce, and W (or the Weight) two Ounces, then to make the Power preponderate, only 2 Penny-weight and 18 Grains was sufficient. N.B. When P is $= 2\frac{1}{2}$, and W = 5, the additional Weight mark'd $\frac{1}{5}$ was 4 Penny-weight and 2 Grains.

It is plain from this, that *Monf. Perault's* Experiments were very inaccurately made, and therefore not to be depended upon.

III. *A farther Examination of the Machine's* said
to be without Friction. By the same.

AT the last Meeting of the Society, I shew'd the Inconveniency of Mons. *Perault's* new kind of *Axis in Peritrochio*, or Roller fix'd into a large Pully; shewing not only, that by the Use of this Engine we must lose Force, whose Value is seldom to be recompens'd by the Time we gain, but also that the Stiffness of the additional Ropes which wind about the Roller, in the Operation, gives more than double (sometimes than triple or quadruple) the Friction of the same Engine us'd in the common Way, when the Pivot, or Iron Axis, is in Diameter the twelfth Part of the Diameter of the Roller, or wooden Axel.

But as some have endeavour'd to render this Engine more useful, by causing it to roll up an inclin'd Plane, instead of making it rise directly up in the Manner describ'd, and condemn'd in my former Paper; I thought proper to shew here what must be the Loss of the Power in Proportion to the Inclination of the Plane.

I say therefore, that in every Inclination of the Plane, if the Sine of the Angle of Inclination be taken in Parts of the Radius of the Axel, or Roller, the Power will be to the Weight :: as the Radius of the Roller + the Sine of Inclination, to the Radius of the Wheel — the said Sine of Inclination; that is, in the Figure, P (= 1) : W (= 3) :: $d k$: $a k$. (See Fig. 4.)

In the present Experiment BE is an inclin'd Plane, on which the Roller C is to roll up, touching the said Plane at the Point c ; AM is the Wheel behind that Plane, another such Plane, and equally inclin'd, being also suppos'd, behind the Wheel, to support the other End of the Roller.

The Lines of Direction of the Power and Weight being aP and dW , through the Point of Contact, or Center of Motion, c draws AD parallel to the Horizon, and perpendicular to aP and dW ; through the Center of the Engine, C draws cd Parallel to AD . Suppose the Angle BcA of the Plane's Inclination to be 30° , the right Sine will then be equal to half the Radius; therefore dividing $C2$ (the Radius of the Roller) into two equal Parts at k , if you draw kc and Cc , the Angle kcC will be equal to BcA , and its Sine will be Ck . Now since it is evidently the same thing to make use of cd for a Lever, whose Center of Motion is at k , as of AD equal and parallel to it with its Center of Motion at c ; it follows that in this Inclination of the Plane, the Distance of the Weight dk is greater than dC (the Distance of the Weight in the common Use of this Engine) by the Addition of the Quantity Ck , the Sine of the Angle of Inclination; and ka , the Distance of the Power is less than Ca (the Distance of the Power in the common Way) by the Subtraction of the said Quantity or Sine Ck : consequently that on an inclin'd Plane; the Power is to the Weight :: as Dc : to cA . Q. E. D.

COROLLARY I.

Hence it follows, that the Radius of the Wheel, and the Radius of the Roller being given, the Loss
 of

of Power may be found in any Inclination of the Plane. Thus, as here, the Power, which in the common Way wou'd be but $\frac{1}{2}$ of the Weight, must be $\frac{1}{2}$ Part of it: So if the Angle of the Plane's Inclination was but $11^{\circ} 32'$ the Power would be $\frac{1}{4}$ of the Weight, &c.

COROLLARY II.

Hence follows also, that if the Plane B E be Horizontal, no Force of the Power will be lost, because $cg : cf :: CG : CF$.

SCHOLIUM.

As the Friction of the winding of the Ropes, such as B c in the new Way, is greater than the Friction of the Pivot in the old Way (besides the Friction of the Collars of the Counterpoise to the Engine) so that Friction diminishes, as the Ropes bear less Weight, according to the Diminution of the Angle of the Plane; and when the Plane is horizontal, and without a Counterpoise, even then the winding up of the Ropes, and Pressure of the Roller against the Plane, is equal to the Friction in the common Way.

N.B. The Experiment is made here with Pivots twelve times less in Diameter than the Roller, and fine pliable Silk, instead of Ropes.

IV. DE EQUULEO:

*Auctore Joanne Wardo, Rhet. Prof. Gresh. et
R. S. S.*

IN quem finem equuleus primo institutus fuerit, et ad quem usum adhibitus, ex multis veterum scriptorum locis satis manifesto constat. Formam autem atque fabricandi rationem cum nemo eorum descripserit, in varias de hac re sententias, easque haud parum a se invicem discrepantes, doctissimi homines abierunt. Neque hoc mirum profecto ei videbitur, qui quam difficile haud raro sit de rebus per multa secula desuetis, et a conspectu remotis, certi aliquid statuere, secum perpenderit; idque praesertim si antiqui auctores, qui eas commemorant, leviter tantum id faciant, nec plene describant. Quod cum equuleo, ut dixi, evenerit; nec ullus eruditorum, qui post renatas literas hanc machinam nobis explicare suscepit, rem adeo feliciter expediisse mihi videretur, ut descriptio cum iis, quae veteres de illa tradunt, per omnia congrueret; certius atque exploratius aliquid assequendi spem omnem prorsus abjeceram. Ceterum inter chartas quasdam Roma transmissas, in quibus variae imagines antiqui operis, jam illic extantes, delineatae sunt, quas vir eruditissimus, et Medicus Regius, RICHARDUS MEADIUS, haud ita pridem mihi conspiciendi copiam praebere dignatus est, in unam forte fortuna incidi, a marmore anaglyptico in palatio Principis *Burgesi* adservato descriptam; quae, ut statim conjectabar, hominem in equuleo suspensum exhibuit. Hujus igitur usu
mihi

mihi perhumaniter concessio, rem totam attentius considerare; loca apud veteres scriptores, in quibus equulei mentionem faciunt, studiosius exquirere; et cum hac imagine diligenter conferre coepi: unde tandem evenit, ut non solum omnes, qui seculis recentioribus de equuleo tractaverant, a vero aberrasse, sed et causas quoque errorum, ut mihi videbatur, plane perspexerim. Quorum utrumque ex iis, quae de antiqua hac machina jam dicturus sum, ni fallor, manifesto apparebit.

Equuleus igitur, si ad vocis originem attendamus, *pullum equinum*, vel *parvum equum*, significat, ut ex his Tullii verbis intelligimus: *Chrysippus omnia in perfectis et maturis docet esse meliora; ut in equo, quam in equuleo*^a. Atque hinc formam, pariter ac nomen, machina, de qua agimus, primo accepit.

Equuleum autem cum *cruce* nonnulli minus recte confuderunt. Crux enim patibulum fuit, cui servi affixi, aliique abjectae conditionis homines, ultimo supplicio afficiebantur. In equuleo autem quaestiones vi tormentorum habebantur ad crimina eruenda. Sic Val. Maximus de servo quodam meminit, qui sexies in equuleo tortus culpam pernegavit; et nihilominus a iudicibus postea damnatus, et in crucem actus est^b. Nec forma igitur, nec fine instituto, equuleus cum cruce conveniebat.

Inter varias autem de equuleo sententias duas tantum, utpote quae propius ad veritatem accedunt, hic memorabo. Altera est Hieron. Magii (quem sequitur Gallonius^c) qui *ad equi imaginem* factum recte iudicavit^d;

^a De N. D. l. 2. c. 14.
c. 3.

^b L. 8. c. 4.

^c De SS. Martyrum cruciat.

^d De equul. c. 1.

altera vero est Caraccioli, qui *stipitem erectum* fuisse haud minus recte censuit^a. In eo autem utrumque lapsum esse (ut de aliis erroribus taceam) quod unam semper formam habuisse existimaverint, jam demonstrare conabor.

Seculis igitur antiquioribus equuleum ad equi imaginem quodam modo fabricabant, dorso in eam longitudinem ac latitudinem complanato, ut hominem in illud porrecto corpore impositum satis convenienter capere posset. Qui torquendus enim erat, non insidebat, sed brachiis sub equulei pectore retortis, vinctis manibus, pedibusque protensis, jacebat supinus. Duabus etiam trochleis diversae magnitudinis equuleum instruebant; quarum minor inter clunes in hunc finem excavatos, major vero, eademque manubriata, sub ventre collocabatur. Tortor autem cum utrumque pedem funiculis vel nervis (qui *fidiculae* dicebantur) ligasset, hos deinde contorquens, ac per trochleam minorem ducens, majori affixit; tum majorem hanc trochleam manubrio circumagens corpus eo usque extendere potuit, dum artus atque ossium compagines haud sine maximo dolore luxarentur.

Jam veterum scriptorum testimonia, quibus haec descriptio confirmari possit, proferemus. Formam igitur equinam ratio nominis (ut supra observatum fuit) aperte satis indicare videtur; sicut apud nos hodie simile quoddam instrumenti genus, quod vocamus *the wooden horse*, ad poenas militares adhibetur. Idem quoque locutiones istae declarant, quae ab equo desumptae de equuleo pariter usurpantur. Ita non tantum *conjici*, et *imponi*, sed etiam *ire in equuleum*, apud

^a Apud Ferrar. Elect. l. 7. c. 5.

Ciceronem legimus^a. Atque hinc Pomponii locus in versibus Atellanis :

Et ubi influi in cocleatum equuleum,

Ibi solutum torto.^b

Ubi voces *influi* et *solutum* ab re equestri aperte traxit poeta. Porro cum *cocleatum* [legerem *trochleatum*] equuleum dicit, cocleis vel trochleis fuisse instructum ostendit. Homines autem in equuleo jacerere solitos docet Seneca, cum ait: *Hoc nobis persuadere conaris, nihil interesse, utrum aliquis in gaudio sit, an in equuleo jaceat*^c. Quin et fidiculis corpus fuisse extensum testis est Fabius, apud quem pater, quod filium torquendo occiderat accusatus, ita loquitur: *An tu quaestionem illam fuisse credis, qualis vernilibus corporibus adhibetur? Ideo enim equuleum movebam artifex senex, tendebam fidiculas ratione saevitiae, ut leniter sedibus suis emota compago per singulos artus membra luxaret*^d. Unde etiam Seneca hominem in equuleo longiorem fieri dicit^e. Atque ut ea de causa manus pedesque adstringi necesse erat; sic illa, qua diximus, ratione id factum fuisse infra ostendemus. Huic autem equulei descriptioni, quod de Zenone philosopho traditur, adprime convenire videtur. Is enim, *cum a Nearcho tyranno torqueretur, doloris victor, sed ullionis cupidus, esse dixit, quod eum secreto audire admodum expediret; laxatoque equuleo, postquam infidiis opportunum tempus animadvertit, aurem ejus morso corripuit, nec ante dimisit, quam et ipse vita, et ille corporis parte privaretur*^f. Jam homo in equulei dorsum, ut supra explicuimus, ja-

^a Tusc. Qu. l. 5. c. 5.

^b Apud Non. in voc. *solutum*.

^c Epist. 66.

^d Declam. 19.

^e Epist. 67.

^f V. Max. l. 3. c. 3.

cens tanto spatio ab humo distabat, ut ori ipsius alius commode satis aurem applicare posset; ideoque cum fidiculas tortor laxasset, attractis parum pedibus, et capite inflexo, aurem ejus morfu facile corripere.

Porro verisimile videtur aeneum taurum, quem confecit Perillus, et Phalaridi obtulit, hinc ortum suum habuisse. Ab hoc enim crudelissimo tyranno homines *ερελαιοθυ* solitos testantur Plutarchus ^a et Aelianus ^b; qua voce Aelianum *equulei extensionem* intellexisse ipse alibi ostendit ^c. Sic in Glossar. Philoxeni, *ερελωτης equuleus*. Cum peritus igitur iste sceleris artifex, Perillus, homines in equuleo tortos gemitibus suis et ejulatibus sonitum, taurorum mugitui non prorsus ab- similem, edere observasset; quo artis adjumento res quam proxime adsimilari posset, de equina effigie in tau- rinam mutanda, hominibusque ei includendis primum cogitasse haud absurde credatur.

Ceterum equina ista species non semper, ut diximus, equuleo permansit; sed posteris aetatibus in aliam longe diversam fuit mutata. Forma autem conversa, ut idem nomen retineret, huic machinae cum multis aliis rebus fuit commune. Nam, ut alias omitam, machina ista bellica, quae ab arietini capitis similitudine *aries* dice- batur, non eam perpetuo speciem habuit, unde ab in- itio nomen accepit ^d.

Equuleus igitur hisce temporibus stipēs erat in altum erectus; cujus summae parti lignum transversum, at- que cornuum more utrinque curvatum, impositum eminebat. Duplici etiam trochlea, ut prior iste, in- trucebatur; minori imae parti stipitis, ad eam recipi- endam excavatae, inserta; ac majori manubriata, pone-

^a Parall. c. 39.

^b Var. Hist. l. 2. c. 4.

^c Apud Suid. in voce

ερελαιοθυ.

^d Vid. Lips. Poliorcet. l. 3. dial. 1

que affixa. Torquendus autem homo in equuleum sublatuſ, brachiis in lignum tranſverſum retortis, manibusque poſt tergum ſtipiti devinctis, pendebat; fidiculis etiam pedes ligabantur, quas per trochleam deinde minorem tranſmiſſas major averſae equulei parti affixa recipiebat, cujus circumactu corpus extendebatur.

Cum de hac autem equulei ſpecie veteris eccleſiae ſcriptores, qui martyrum acerbiffimos cruciatus ſub Romanis imperatoribus literis conſignarunt, ſaepiſſime mentionem faciant; eorum potiſſimum teſtimoniis utemur in forma illius demonſtranda. *Stipitem* inter alios S. Hieronymus appellat ^a. Item Prudentius:

Jubet amoveri noxialeſt ipitem ^b.

Atque in altum fuiſſe erectum ex eo apparet, quod torti homines in illo *ſuſpendi* ac *pendere* dicebantur; ut ex Euſebii & Prudentii verbis mox adducendis videbimus. De ligno tranſverſo nihil apud antiquos auctores invenio; quod multis eruditorum al-lucinationibus in hac machina deſcribenda cauſam dediffe, fas eſt ſuſpicari. Sed in imagine, quam infra delineatam exhibebimus, lignum illud bicornè plane conſpicitur. Trochleis quoque inſtructum fuiſſe, ex illis Euſebii verbis colligi poteſt: *Quidam, manibus poſt tergum revinctis, ad ſtipitem ſuſpenderantur, ac membrum unumquodque περιειρως quĩ-ſuſdam diſtendebatur* ^c. Ubi vocem περιειρως, quae machinae cuicunque fere nervis aut manubrio inſtructae convenit, plurali numero adhibens, trochleas ſignificare videtur. Porro ut manus poſt tergum

^a Epift. ad Innoc. 49.
Eccleſ. l. 8. c. 10.

^b Περὶ ſτῆς, Hymn. 10. v. 114

^c Hiſt.

vinctas fuisse hic docet Eusebius; sic brachia retorta memorat Prudentius, ubi iudicem ita imperantem inducit:

*Vinctum retortis brachiis
Sursum ac deorsum extendite,
Compago donec ossium
Divulsa membratim crepet^a.*

Item pedes vinciri solitos ex alio ejusdem poetae carmine apparet, in quo martyr ex equuleo sic loquitur:

*Miserum putatis, quod retortis pendeo
Extentus ulnis, quod revelluntur pedes^b.*

Quo pedes autem revelli possent, prius adstringi debebant. Ex utriusque etiam scriptoris verbis stipitem, ut diximus, erectum fuisse apparet. Atque hinc iudex *sursum ac deorsum* eodem tempore corpus extendi jubet. Etenim hac corporis positione, dum pedum revulso inferiores ejus partes deorsum extenderentur, humeros transverso ligno suffultos, nexuque manuum ad stipitem repressos, sursum protrudi atque luxari necesse erat. Et quia ab humo elevati pendebant, hinc apud Sozomenum praeses Christianum hominem in equuleo torquendum *ἀνωρῶνται*, *sublimen tolli*, praecipit; cui is, latera nudans, non opus esse inquit, ut lictores ipsum in equuleum levando, ac postea deponendo, frustra defatigentur^c. Imo quo poenae conspectiores essent, equuleos in catasta fuisse constitutos, haud male sensisse videtur Ferrarius^d; de qua martyris verba apud poetam, jam saepius laudatum, intelligi posse observat:

Emitto vocem de catasta celsior^e.

^a Ubi supra, Hymn. 5. v. 109.
Eccles. l. 5. c. 2.

^b Ibid. Hymn. 10. v. 491.
^d Elect. l. 1. c. 6.

^c Hist.
^e Ubi supra, Hymn. 10. v. 467.

Quibus et illa, ni fallor, ejusdem carminis adjungi possint:

*Incensus his Asclepiades jusserat
Eviscerandum corpus equuleo eminus
Pendere*^a.

Catasta autem pagma vel tabulatum est, in quo apud nos quoque ii collocantur, quibus *numellae* poena infligitur. Sigonium^b igitur, aliosque viros doctissimos, catasta de ipso equuleo perperam accepisse censet Ferrarius. Et revera, ni equuleus in catasta collocatus esset, qua ratione *corpus* in eo *eminus pendens* tortores ungulis suis ferreis *eviscerare* possent? Proinde fidiculas ad corpus extendendum in hac forma equulei, aequae ac priori, adhibitas fuisse, ex Codice Justiniani discimus; ubi Valentiniani imp. edicto *decuriones exsortes omnino earum esse poenarum, quas fidiculae et tormenta constituunt*, jubentur^c. Hisce autem verbis equuleum veteres haud raro describere satis notum est.

Jam si verba et locutiones, quae diversis temporibus equuleo tributa sunt, paulo attentius consideraremus; eidem formae nequaquam congruere, necessario fateri cogemur. Primum enim ex novo adjecto nomine formae mutationem colligere licet. Nam vox *stipes* machinae ad equi imaginem factae nullo modo convenire potuit. Quare aut effigiem equinam, contra certam vocis *equulei* interpretationem, ac veterum locutiones ab illa desumptas, nunquam habuisse dicendum est; aut cum *stipes* deinceps vocari coepit, aliam formam accepisse. Praeterea antiquius *jacere*, postea vero *pendere* et *suspendi* in equuleo

^a Vers. 108.

^b De Judic. l. 3, c. 17.

^c L. 16. de quæst.

homines

homines dicuntur ; qui duo corporis situs, tam longe diversi, formam machinae haud minus diversam requirunt. His accedit, quod alteri formae alterum effectum adscribi videtur. Vetustioribus enim seculis corpus simpliciter *extendi* dicitur, utpote in planum porrectum ; sequentibus vero aetatibus *fursum ac deorsum*, quod pendenti convenit, id fieri jubetur. Denique in priori equuleo homo decumbens ea fuit altitudine, ut in aurem alicui susurrare posset ; quod in posteriori suspenso propter nimium a solo spatium haud omnino congruit. Et quis jam non videt hanc verborum ac locutionum discrepantiam ad duplicem equulei speciem necessario referendam esse ? Certe homines isti eruditi, qui aliter senserunt, dum omnia apud veteres de hac re loquendi genera sententiae suae accommodare conati sint, eis difficultatibus fuerunt impliciti, unde nullo modo sese explicare potuerunt.

Verum ne qua hoc in dubium vocandi ansa in posterum restet, duo testimonia ex iis temporibus, quibus stipitis formam equuleo supra tribuimus, a Gallonio in contrarium allata^a, breviter diluemus. Alterum ex illis S. Hieronymi verbis petitur : *Cum equuleus corpus extenderet, et manus post tergum vincula cohiberent ; oculis, quos tantum tortor alligare non poterat, suspexit ad caelum*^b. Ex quo loco necesse esse, ut in equuleo torti corpore prostrati jacerent, contendit Gallonius. At nemo non clare perspiciet, hominem eo modo, quo diximus, suspensum, acque facile *ad caelum suspicere* posse, ac si corpore supino jaceat. Alterum testimonium ex

^a De SS. Martyr. cruciat. c. 3.

^b Epist. ad Ianoc. 49.

Amm. Marcellino adducitur: *Innocentes tortoribus exposuit multos, vel sub equuleo cepit* [rectius *Valesius caput*] *incurvos, aut ictu carnificis torvi substravit*^a. Et alibi: *Quaquam incurvus sub equuleo staret*^b. Unde idem vir doctus novum quoddam et inauditum cruciandi genus excogitavit; quasi tortores nonnunquam doloris augendi gratia, laxatis funiculis, corpus sub ventrem equulei cadere, atque ibi incurvatum pendere sinerent. Verum non *sub equuleo cecidisse* vel *pependisse* dicit Ammianus, sed *stetisse*: quod qua ratione cum Gallonii sententia convenire possit, non intelligo. Sed quia mos fuit eos, qui in equuleo torquendi erant, prius flagellis verberari, *incurvus* fortasse dixit, quod verberibus laceratus recto corpore stare amplius non potuit; idque *sub equuleo*, hoc est, juxta equuleum; ut cum dicitur, *sub hasta venire*^c: quod de voce etiam *incurvos* in altero Ammiani exemplo pari ratione dici potest. Ni quis potius de catenis onustis, earumque pondere incurvatis, voces istas intelligere malit; quemadmodum et in re simili scribit Paulinus Aquitanus:

*Moestorum pallens infelix ordo reorum
Haerebat, nexis per squallida colla catenis;
Incutiens fractis stridentia vincula membris,
Et motans tardos, incurvo pectore, gressus*^d.

Hic voces *incurvo pectore* eodem sensu, quo Ammianus *caput incurvos*, usurpasse videtur. Nonnullos etiam ex hoc infelici ordine equuleo destinatos fuisse post pauca significat.

^a L. 26. c. ult.
Martini l. 5. v. 261.

^b L. 28 c. 1.

^c Liv. l. 5 c. 16.

^d De vit. B

*Ast alii sursum porrecti robora ligni,
Triste ministerium, furioso corde parabant ;
Ut caro distentis propere, male pendula, membris
Tortori laceros crucianda exponeret artus.*

Ubi etiam verba *sursum porrecti robora ligni, et caro pendula*, erectam equulei formam plane demonstrant.

Ceterum cum neque verberibus, neque membrorum extensione, ut rem quaesitam confiteretur, homo tortus evinci potuit ; ignes et ardentes laminae aevis antiquioribus corpori admovebantur. Ita Fabius, rem totam ordine recitans : *Ego scindo vestes, tu intremiscis ; ego ad flagella nudo corpus, te facit pallor exanimem ; ego equuleos, ego posco flammam ; tu non habes in meo dolore patientiam*^a. Et V. Maximus : *Rupit verbera, fidiculas laxavit, solvit equuleum, laminas extinxit ; priusquam efficere potuit, ut tyrannicidii socios indicaret*^b. Sequentibus autem seculis, cum jam stipitis speciem equuleus receperat, hisce omnibus torquendi modis ungulae etiam ferreae adjiciebantur, quibus latera et aliae corporis partes laniari solebant. Sic in Codice Justiniani praecipitur : *Si convictus fuerit, et ad proprium facinus detegentibus repugnaverit pernegando, sit equuleo deditus, ungulisque sulcantibus latera perferat poenas proprio dignas facinore*.

Attamen quo tempore haec formae immutatio inter Romanos fieri coeperit, pro certo affirmare nequeo. Ad Fabii saltem aetatem, hoc est, imperium Domitiani, speciem mansisse equinam eo credibile videtur, quod pater, qui in Declamatione supra citata ob fili-

^a Declam. 7.^b L. 3. c. 3.^c L. 7. de malefic.

um a se tormentis occisum defensionem sibi instituit, tanquam *jacentem* in cruciatibus illum describit. Ratio autem mutationis satis, opinor, probabilis adferri potest. Inferioribus enim Romani imperii aetatibus non tantum Christianos, sed alios etiam eximiae dignitatis homines majestatis crimine postulatos, equuleo traditos fuisse saepius legimus. Quamdiu autem in quaestionibus jure constitutis solum adhibebatur, nihil amplius erat necessarium, quam ut ea, quae a reo dicerentur, ipsi judices, alique quorum interesset, exaudire possent; cui proposito forma equina satis conveniebat. Postea vero cum crudelissimis istis tyrannis ad suspicionibus suis indulgendum, atque Christianos vexandum, hac machina abuti placuit, erecta forma sine dubio omnium fuit commodissima. Nam ita crucis speciem quodam modo referebat, quo major poenae esset ignominia; et praeterea homo tortus oculis circumstantium ad alios deterrendos magis exponebatur. Apud Graecos sane, unde Romani acceperunt, figuram equinam in usu fuisse, cum Perilli taurus, tum etiam Zenonis historia supra memorata, manifesto satis declarare videntur.

Verum enimvero ut discrimen inter has duas machinas clarius pateat, ac melius inter se conferri possint, utriusque imaginem hic conjunctim exhibebimus.

Prior forma equulei, A.

Posterior forma equulei, B.

Priori adstat tortor, majoris trochleae manubrium tenens, quo hominem in dorsum equulei impositum extendat. Posterior autem, quam a clarissimi MEADII exemplari delineatam dedimus, tres humanas figuras habet

habet adjunctas ; quarum una est hominis in equuleo suspensi, duae reliquae sunt tortorum. Ex his alter, chlamyde (quam vestem tortori etiam tribuit Hieronymus ^a) ab laevo humero pone rejecta, dextrum equulei cornu dextra prehendit, quasi recte aliquid compositurus ; alter vero, utpote prioris adjutor, nudus, ac genu nixus, ad pedes torquendi hominis vinciendos se parat. Quod sinistrum autem equulei cornu dextro sit brevius, injuria temporis accidisse credamus ; quia summa pars plane abrupta esse videtur. Quaedam aut ipse artifex, aut saltem delineator omisit. Etenim nec inferior pars stipitis, ubi conspici posset, nec trochlea ad imum conspicitur : nam alteram trochleam pone collocari solitam supra notavimus. In eo autem alteruter manifesto erravit, quod hominem in equulco ita constituerit, ut pedum digitis solum tangere videatur ; quod neque pendenti, neque veterum testimoniis de hac re supra adductis, omnino convenit. Sed vetustis hujusmodi monumentis haud raro accidere invenimus, ut partes praecipuas, et quae summam operis continent, artifices diligenter ac studiose effinxisse contenti, reliquas vel prorsus neglexerint, vel minus saltem accurate expresserint. Ceterum ne quis ea diutius frustra requirat, quae in exemplari desiderantur, seorsim delineata oculis subjecimus, una cum tortore trochleam convertente. Arcus autem, qui juxta hominis suspensi caput sinistrorsum conspicitur, nihil cum equuleo habet commune ; sed ostii alicujus partem, carceris forsitan unde productus fuit, exhibet.

Jam si duplicem hanc equulei formam, ac singulas partes inter se conferamus, eundem plane torquendi

^a Ubi supra

modum sub diversa specie utrique fuisse facile videbimus. Si priorem enim, ad equi imaginem factam, in altum modo erectam mente concipiamus; trochleae, fidi-
culae, retorsio brachiorum, et totius corporis exten-
sio, haud aliter atque in posteriori constitui apparebunt.
Praeterea nihil difficile, nihil operosum videtur; sed fa-
cilis et expedita cruciandi ratio nobis se offert, quae
in publicis suppliciis praecipue requiritur.

At nequis post omnia, quae hactenus dicta sunt, *furcam*, hoc est, *crucem* ad furcae imaginem factam, pro equuleo nos protulisse suspicetur; sciendum est hanc equulei speciem furcae non admodum fuisse dissi-
mitem. Hoc Theophili cuiusdam verba; a Gallonio plane contra sententiam suam allata, demonstrant: *Ecce*, inquit, *modo Christianus sum, quia in cruce, id est in equuleo, suspensus sum. Equuleus enim crucis quan-
dam similitudinem gerit*^a. Nihilominus tamen furca in multis ab equuleo differebat. Primum enim ima pars cornuum ad formam V literae in acumen coibat; deinde cornua multo erant longiora; praeterea, qui in furcam agebatur, brachiis supra caput, non post tergum, re-
tortis pendebat; denique manus haud stipiti conjunctae, sed cornibus dispanfac ligabantur, ut ostendit Lipsius^b. Et tamen alibi vir idem eruditissimus Ausonii verba de *Cupidine torto* cruci assignat^c, quae ad equuleum omnino referri debent. Locus Ausonii ita se habet:

*Hujus in excelsa suspensum stipite Amorem,
Devinctum post terga manus, substrietaque plantis
Vincula moerentem, nullo moderamine poenae
Adfigunt*^d.

Cum poeta hic ait, *devinctum post terga manus*, non crucem, sed equuleum plane describit. Porro cum

^a De SS. Martyr. cruciat. c. 3. ^b De cruce, l. 3. c. 6. ^c Ibid. l. 1. c. 5. ^d Edyll. 6.

Sulpicius Severus de B. Martino loquens ait, gloriam martyris eum adeo affectasse, ut, si licuisset, *equuleum sponte ascendisset* ^a; machinae figura ac ratio suspensionis, quemadmodum id facere potuisset, aperte satis ostendunt: in furca autem se ipsum nemo suspendere potuit.

In summa autem, cum tota hujusce rei probatio veterum scriptorum testimoniis praecipue nitatur, ut plura adferre, quae haud parva copia sese obtulerunt, supervacaneum duximus; ita nec pauciora ad plenam ejus explicationem sufficere existimavimus. Verum quaecunque de ea apud antiquos leguntur, uni aut alteri speciei supra descriptae facile tribui possunt. Qui ad auctoris igitur aetatem, et diversos loquendi modos diversis temporibus de equuleo usurpatos attenderit; nihil, opinor, difficultatis in posterum inveniet, quid de hoc tormenti genere statuere debeat; in quo explicando tot viri eruditi haecenus se frustra torserunt.

^a Epist. 2.

V. *An Account of a Treatise entituled, Calculations and Tables relating to the attractive Virtue of Loadstones, &c. Printed Anno 1729.*

THE Author, (the Hon. Lord *Paisley*) by several Experiments very carefully made, has observed, that if two Loadstones are perfectly homogeneous, that is, if their Matter be of the same specifick Gravity, and of the same Virtue in all Parts of one Stone, as in the other, and that like Parts of their Surfaces are cap'd or arm'd with Iron, then the Weights they sustain will be as the Squares of the Cube Roots of the Weights of the

Loadstones; that is, as their Surfaces. Upon this Principle the Tables are formed. The first Column of these Tables is in common to the four following, and helps to shew how many times its Weight any Loadstone sustains.

In the second, third, fourth and fifth Columns, are the Weights of Loadstones in different Denominations. The second, entituled Grains, reaches Grain by Grain to 480 Grains, or one Ounce, and will serve for any Loadstone, whose Weight does not exceed one Ounce. The third reaches, by Penny-weights, up to two Pounds, or 480 Penny-weights, and therefore serves for any Stone that weighs not less than one Penny-weight, nor more than two Pound. The fourth Column reaches, by Ounces, up to forty Pounds, or 480 Ounces, and therefore will serve for any Stone not exceeding that Weight. The fifth serves from one to 480 Pounds. The sixth Column entituled, Weight sustained, is in common to the four preceding; and the Numbers in this Table, if they were divided by 10, would be the Squares of the Cube Roots of the Numbers in natural Order, from 1 to 480, as they are found in the Column of Pounds. But these Squares of the Cube Roots are here multiplied by ten, because a Loadstone of the very worst Sort, if it weighs but one Grain, will sustain ten Grains; and so these Tables, by simple Inspection, shew what Number of Grains any Loadstone of that worst Character would sustain, if the Stone weigh not more than 480 Grains, or one Ounce. The Numbers in the first Column entituled, How often its Weight, are proportional to the Reciprocals of the Cube Roots of the natural Numbers, and are form'd by dividing the Numbers of the sixth Column, by the
the

the corresponding natural Numbers, as they are found in the Column of Pounds.

For the greater Convenience of Calculation, his Lordship has added Tables; first of Decimal Parts for Penny-weights, Ounces, and Pounds, in order to lose as little as possible of the Fractions, in the several Calculations. The next are Tables of Grains, Penny-weights, Ounces, and Pounds, which readily shew how many of each Denomination are contained in the others. The Tables entituled, From Grains to Penny-weights, &c. and the others from the several Denominations to others, are of Use for carrying the Computation readily from any one Denomination to another: And lastly, the Tables at the Bottom of these last mention'd are of the like Use, for the ready finding the Value in Money of any Loadstone, from the Numbers proper to Grains, to Penny-weights, to Ounces, and to Pounds.

The Honourable Author then proceeds to explain the Use of these Tables, by Instances under each Denomination. Thus, if a Loadstone does not exceed one Ounce, or 480 Grains, the particular Weight of the Stone, with the Weight it sustains, being known, he reduces the Weight sustained to Grains, by the Help of the Table of Grains. Then looking into the Column of Grains for the Weight of the Stone, against it, in the Column of Weight sustained, he finds the Number of Grains, which a Stone of the worst Sort of this Weight would sustain; and then dividing the known Number of Grains which this particular Stone will sustain, by the Number of Grains expressed in the Column, the Quotient shews the Character of Goodness in the Stone propos'd; and by the Help of this Number may be known what Weight any other
Stone

Stone of equal Goodness with this would sustain, let its Weight be less or more, provided it does not exceed one Ounce, or 480 Grains. For looking into the second Column for the Weight of the Stone, and having found against it, in the sixth Column, the Weight sustained by a bad Stone, if you multiply the Quotient above found, which shews the Character of Goodness, by the Number in the Tables expressing the Weight sustained, the Product is the Number of Grains this particular Stone will sustain.

If a Stone of the same Character weighs more than one Ounce, or 480 Grains, and less than two Pound, to know what Weight this will sustain, the Computation must be transferred from the Column of Grains to that of Penny-weights. Now since one Penny-weight is equal to twenty-four Grains, and the Weight sustained is to be expressed, not in Grains, but in Penny-weights, the former Number, which gives the Character of Goodness of the Stone for Grains, must be altered, to do the same thing for Penny-weights. Multiplying therefore this Number by the Reciprocal of the Cube Root of 24, the Number of Grains contained in one Penny-weight (and the Numbers in the Tables are formed accordingly) the Product gives the Number shewing the Character of Goodness in this Stone, which being found, the remaining Part of the Operation is the same as in the former.

If a Loadstone exceeds 480 Penny-weights, and is less than forty Pound, we must in like manner find the Number of the Stone for Ounces; which may be done either by the Number already found for Grains, multiplying it by the Number against Unit in the Table from Grains to Penny-weights, or by the Number for Penny-weights, multiplying it by the Number

ber against Unit in the Table from Penny-weights to Ounces, and the Product is the Characteristick Number of this Stone. Proceeding therefore as in the first Instance, the Weight it will sustain will be found.

The Column of Pounds is only useful where a Loadstone's Weight exceeds forty Pound, or 480 Ounces, in which Case the same Method must be used as in the others.

To know how many times a Loadstone will take up its own Weight, multiply the Number proper to the Denomination in Use, by the Number in the first Column (entituled, How often its Weight) which is against the Weight of the Stone in the Column of that Denomination.

His Lordship closes his Account with explaining the Use of the Tables relating to the Value of Loadstones in Money; and this he supposes to be in the compound Proportion of the Goodness of the Stone, and of the Weight it sustains; because if two Loadstones take up the same Weight, the lesser is more valuable, as it does more in Proportion to its Bulk, and what better Rule to estimate the Value by, than the Goodness of the Stone? On the other Hand, if the Stones are in Nature equally good, but sustain different Weights, it is reasonable, that their Value should be according to the Weights they sustain. Both these Circumstances therefore being considered together, in order to find the Value of any Loadstone by the Tables, we must multiply the characteristick Number for the Stone, by the Number entituled, Value in Money, taking this Value in Money from the particular Denomination that the Stone comes under; and this Product will be the Value, *per Ounce*, of what the Stone sustains. Then multiplying:

multiplying this Value *per* Ounce, by the Number of Ounces the Stone sustains, will give the Value in Money of the Stone proposed.

VI. *An Account of a Book entituled, Jo. Frider. Weidleri Observationes Meteorologicæ & Astronomicæ, Annorum 1728 & 1729, &c. Wittembergæ, Anno 1729.*

THE Author, after dedicating his Tracts to the Royal Society, gives a Description of the particular Sort of Barometer, Thermometer, Hygrometer, and Hyetometer, which he made use of in the subsequent Observations. The first of these is a Diary of the Weather, from the Vernal Equinox of the Year 1728, to that of the Year 1729; containing the daily State of the Barometer, Thermometer, Wind and Weather, together with the Quantity of Rain during that Time. To this he annexes some *select* Meteorological and Astronomical Observations, which he describes more at large.

The first he takes Notice of is a remarkable *Halo* round the Moon, on *February* 20, 1728, at forty-five Minutes past Seven in the Evening, when the Moon was not far distant from the Meridian, and about her first Quarter. The Diameter of the *Halo* occupied about 47 Degrees, being extended from ϵ in *Procyon* to *Capella* towards the West. Its Arch was $4\frac{1}{2}$ Deg. broad, as far, for Instance, as α and ϵ in *Procyon* are from each other. Within it was red, and towards the Extreimity was pale; exhibiting entire a beautiful Spectacle

Spectacle for about four Minutes, but he did not know when it began. Before it dispersed, some thin white Clouds began to pass over it transversely, and then it was broke towards the West, the Redness of the dispersing Vapours greatly encreasing: After which the Sky became clear again. The same Day at Noon, he observed thirteen Spots on the Sun, the largest equalling $\frac{1}{4}$ of the Sun's Diameter; and the Spirit fell to 90 Degrees of the *English* Thermometer.

April 4, 1728, he observed an *Aurora Borealis*.

On *June 20*, another, which is described in the *Aff. Erudit. Lips. Ann. 1728. p. 375*.

October 7, a very remarkable one appeared in the N. E. A *White Arch*, extended between the W. and N. E. quickly assumed a black Colour, and then divided into three other concentrical Arches equally black. From these some Radiations arose as usual, but shorter. A little afterwards these likewise ceas'd, and the black Arches were converted into luminous Tracts, only one remained till eleven o' Clock: And whereas at first the lowermost Arch was raised seven Degrees above the Horizon, it was now depressed towards it, being scarcely two Degrees above it.

The Author next proceeds, and gives fourteen Astronomical Observations, ten of which are of the Eclipses of *Jupiter's Satellites* at different Times. In making these he was guided by *Cassini's* Tables for the Meridian of *Paris*, and by comparing the Time when they should happen, as therein specified, with the Time he observed them at *Wittemberg*, he collects the Difference of Meridians of that City and *Paris* to be 41 Minutes.

The eighth Observation contains his *Calculus* for the total Eclipse of the Moon which happened *February 13, 1729, N. S.* but the Heavens being very cloudy, he could not observe the Eclipse itself.

The ninth is an Observation of *Mercury, March 4, 1729*; at which Time the Planet was farthest from the Sun, and remained some Time above the Horizon. Making use therefore of a twenty-two Foot Telescope, he observed its Phase almost bisected, and its Diameter appeared equal to a third Part of the Diameter of *Venus*, this Planet being above the Horizon, and seen at the same Time.

The thirteenth is a Conjunction of *Venus* and the *Moon, viz. April 2, 1729*. At 7 H. 13' he observed *Venus* placed in such manner near the *Moon*, that the Horns of the *Moon* were in the same right Line with *Venus*, which was then distant from the Southern Cusp of the *Moon* 1 Deg. 10' At 7 H. 30'. he measured the Distance of *Venus* from the Eastern Cusp of the *Pleiades* to be 2 Deg. 15', and the Horn of the Moon at the same Time was distant from the same Cusp 1 Deg. 53', 45''; the intermediate Distance of the Horns of the *Moon* was 29' 30''.

His last Observation is on the Declination of the Magnetical Needle in this and the former Year, which he defines to be 12 Deg. 0' 55'' West at *Wittemberg*, at this Time.

These Observations are followed by the Author's Account of the last hard Winter. This set in sooner than usual, the Rivers being frozen the 19th of *September*, though they used not to be so till the Winter Solstice, and the Spirit of Wine in the *English* Thermometer, on *September 21*, fell to the 66th Degree:

At

At which Time a N. E. Wind blew very strong. Afterwards, on *October* 3, the Spirit fell to 72 Deg. and the Ice was half an Inch thick on standing Waters in the Fields, so that even then it might be judged, that the Cold would be more severe than is usual in their Parts. From this Time the Frost did not at all abate, but continued much in the same State the Month of *October*, except on the 20th Day, after a S. W. Wind had blow'd pretty hard for some Days, the Cold was observed to encrease remarkably. The Beginning of *November* a strong East Wind continuing to blow for six Days, the Spirit sunk to 86 Deg. on the fifth, and the Ice was much thicker. On the 28th it fell to 96 Deg. after which they had no Rain, but all Vapours were congealed into Ice and Hoar. On *December* the 2d, the Spirit of Wine stood at 96 Deg. but on the 4th at 99 Deg. so that it not a little exceeded the Limit of intense Cold. Hence a S. W. Wind intervening now and then, the Cold seemed to abate a little; but that, and sometimes a N. E. Wind blowing stronger on the 21st, 22d, and 23d Days, it so prepared the Air, that on *Christmas* Day the Spirit in the Thermometer stood at 96 Deg. and the Cold was intense. Hence the Winter grew immediately more severe. The Wind almost always blew from the E. or N. so that on *January* 20, the Cold was almost intolerable, on which Day the Spirit descended to the 126th Deg. very little remaining above the Ball of the Tube; and this was the greatest Degree of Cold at *Wittemberg*. After this the Winter somewhat declined. A S. W. Wind blew fresh sometimes; but afterwards a N. and E. Wind restored the Cold on *February* 3, when the Spirit stood again at 86 Deg. On the 4th it fell to

95 Deg. and from this Time, barring a few Days, always in a Morning it reciprocated between 80 Deg. and 100 Deg. to *March* the 8th, on which it exceeded 106 Deg. and on the 9th it was forced down by a N. E. Wind to 110 Deg. But although the Spring was at Hand, yet the Severity of the Weather did not cease, as appears in that the Spirit of Wine, in the *English* Thermometer, in a Morning always stood at, or under the 80th Deg. of the Thermoscopick Scale; nay, even on *March* the 21st, on which Day the Equinox precisely fell, it was at 81 Deg. At length, on the last Day of *March*, the Weather grew milder, from whence may be taken the true Beginning of the Spring; not but that all *April* was much colder than usual.

Thus far from Thermoscopical Observations. After this, the curious Observer proceeds to shew its Severity from some of the more remarkable Effects the Cold had on the Rivers, Plants, and Animals. As to the first, he says, that the *Elbe*, both at *Wittemberg* and other Places, was covered on *December* 29, with a perfect Bridge of Ice, which bore both Men and all Sorts of Carriages. This remained till *February* 28, when it grew thinner, and broke considerably; but the Cold returning on *March* 8, it re-united, and was as firm as before, till *March* 29. The Water within the Houses, and in the Bed-chambers, where were good Fires, was wholly congealed, and the Rind within on the Windows stuck for many Days, when the Wind was either E. or N. though the Room was well warmed. Examples of the other Kinds were several. Many Persons perished in their Journeys, and more lost their Limbs in a very short Time: So that near the
Elbe

Elbe they could not work abroad. It killed also many Animals immediately. The Crows, which can bear intense Cold, fell dead from the Trees: Stags, Goats, and Hares perished in great Numbers. The Plants likewise felt its Violence, and the more tender Trees were damaged. The Limes were every where injured: The greater Branches of the Plumb-trees, Apricots and Peaches, were dried up; but the Vines suffered most, the more robust being shriveled to the very lowest part of their Trunk, unless guarded by a Wall; or some other Covering.

From these Observations the Author compares this Winter with the memorable one of 1709, and proves both from Thermoscopical Observations; from its Effects upon the Earth and Animals; from its longer Continuance, and from the greater Extent of the Cold into the more Southern Parts, that this last much exceeded the former, at least in *Germany*.

Having thus finished the History, he lastly enquires into the probable Causes of it. He takes Notice, that the Winter foregoing was moderately cold and dry; and as a cold Summer succeeded, and alike dry, in which the North Winds blew most frequently, and during the hottest Months of *July* and *August* the Sky was covered with dark and black Clouds, the Earth was prepared for Frost; to which the remarkable Dri-ness of the Season did not contribute a little, as Barometrical Experiments shew, that a dry Air cools sooner than a moist, and is both heavier, and retains Cold longer. Neither does he think it altogether foreign to Truth, to reckon the remarkable Frequency of the *Aurora Borealis* to be a Presage of a colder Winter than ordinary, which has been observed to be followed

by cool and serene Weather : As also the unusual Number and Largeness of the Spots on the Sun's Disk, for almost two Years together ; by which Means, in such a Length of Time, the Force of its Rays might be obstructed in some Degree, and the colder Winds thereby have Liberty to prevail. The Air by these concurrent Causes being rendered very cold, the Encrease, and extreme Degree of it proceeded from the great Cloudiness of the Sky ; and the blowing of the N. E. or E. Wind, so remarkably observable for the most part of the Frost.

VII. *Occultatio Veneris à Lunâ subeunte Berolini visa die 19 Septembris 1729, N. S. p. mer. à D. Kirchio. Ex Diario Meteorologico (M.S.) J. Fred. Weidleri, L. L. D. & Math. Prof. Prim. Wittembergæ.*

CONTIGIT Accessus Lunæ ad Venerem 2 H. 2^m 16^m. Occultatio totalis 2 H. 3^m 1^m. Idem, per Telescopium octodecim Pedum notavit Venerem ferè in Quadraturâ positam, cum prope Lunæ discum accederet, figuram mutasse, & Falcis cuspides amisisse ; unde Ovalis vel Elliptica figura oriebatur : Quod spectaculum pro comprobandâ Lunæ Atmosphærâ laudari posse *D. Kirchius* censet.

L O N D O N :

Printed for W. INNYS, at the West-End of St Paul's Church-Yard.

MDCCXXX.

Fig. 1.

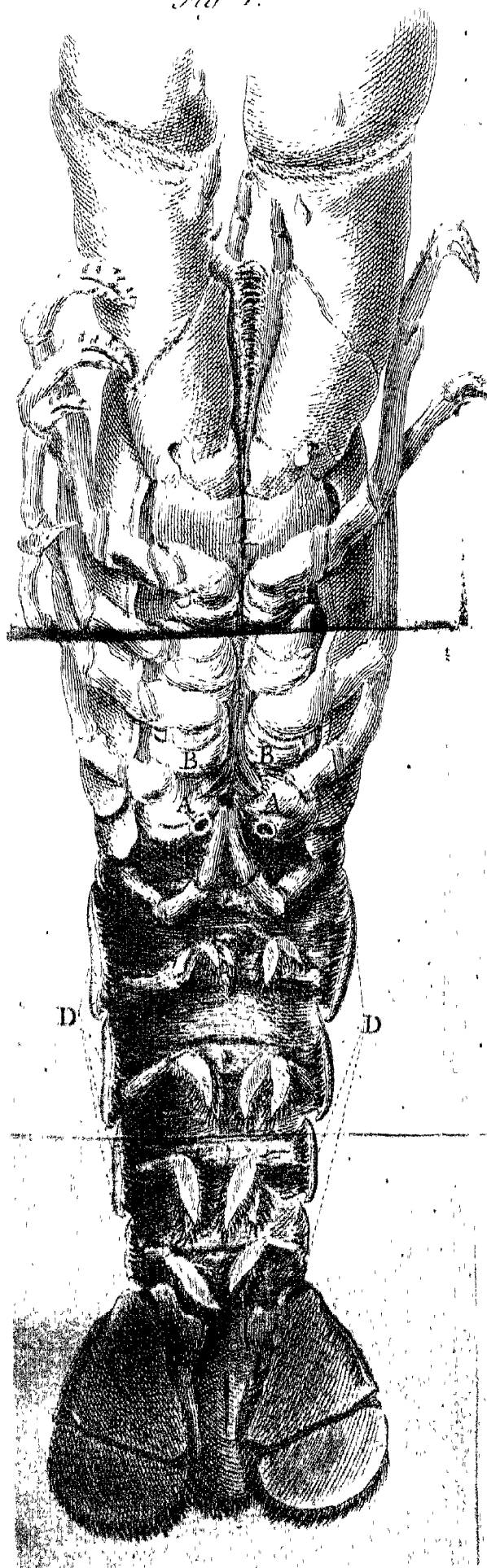


Fig. 2.

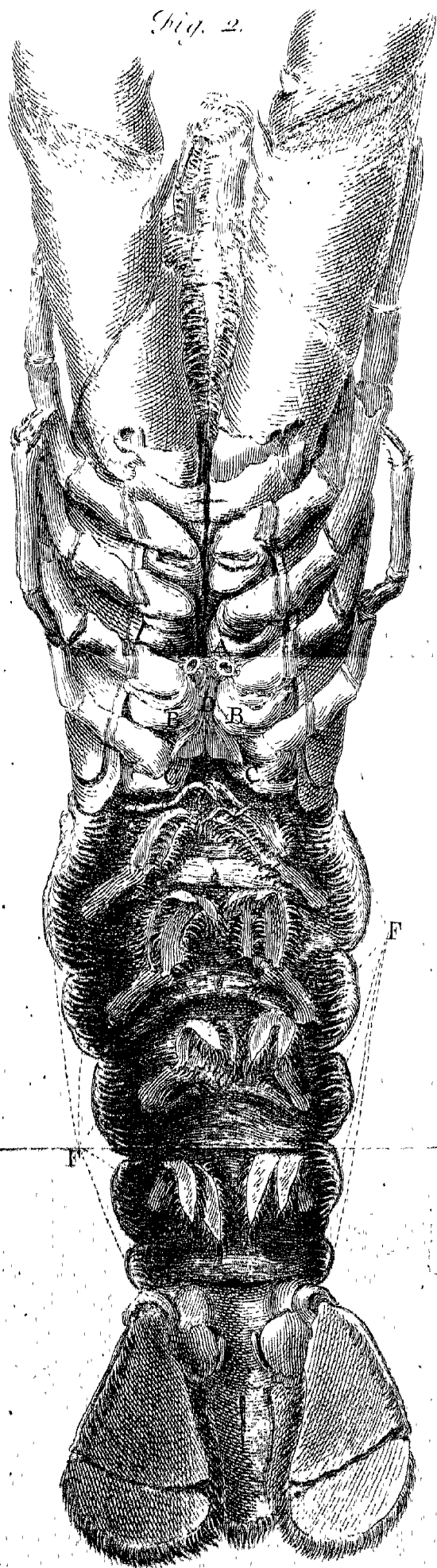


Fig. 3.

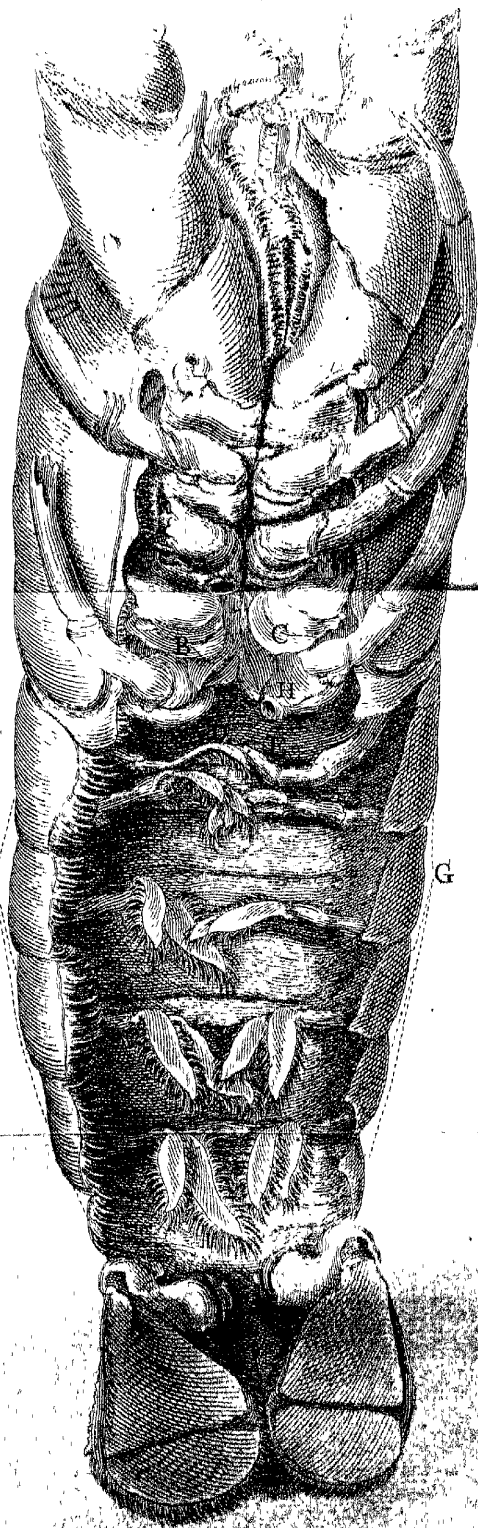
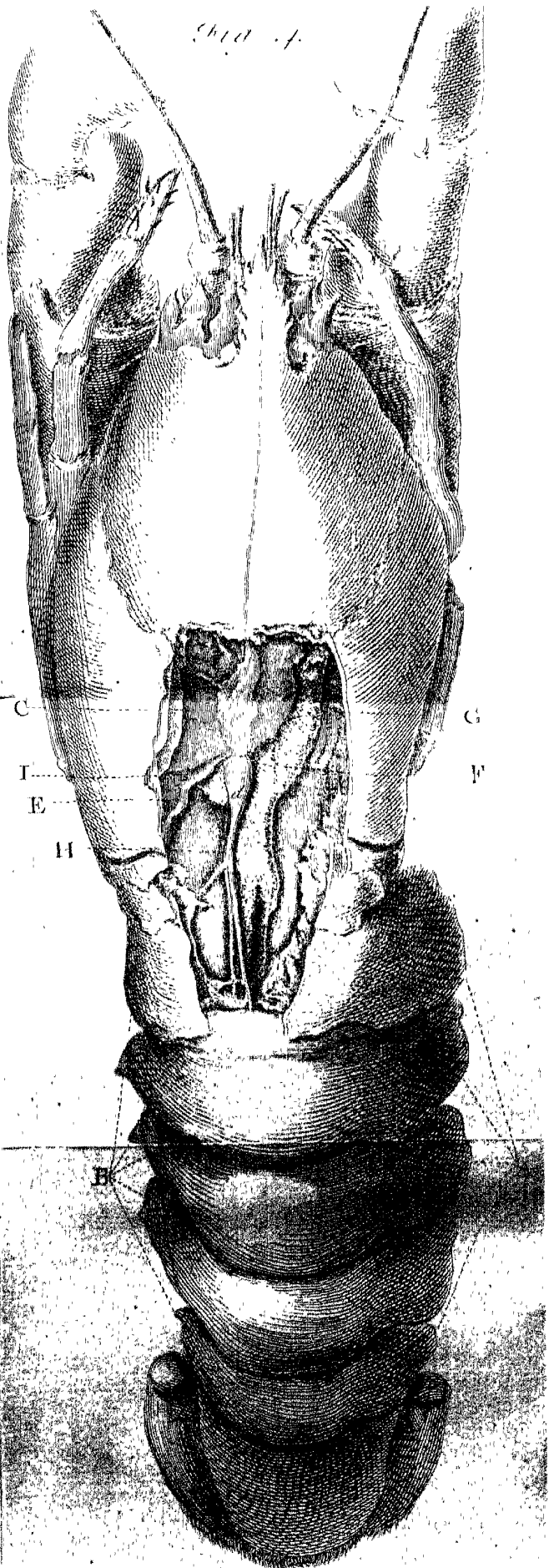


Fig. 4.





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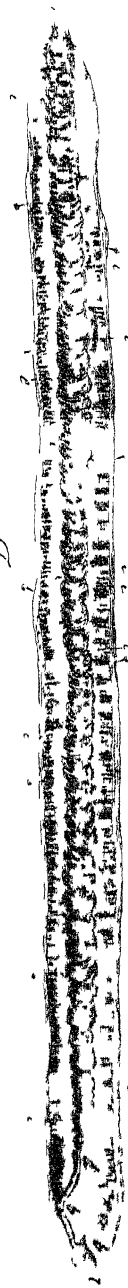
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Fig. 1

... 170000. 170000.

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *March* and *April*, 1730.

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L O N D O N :

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M D C C X X X.

I. *Casus Rarissimus. Ex Epistola Doctissimi Viri
J. Huxham ad Gul. Rutty, M. D. R. S. Secr.*

Nihil fere quam in Pelvi renali & Urinaria Vefica Calculos invenire frequentius : At quis unquam in ipsa Urethra Calculum ponderis unc. quinque cum semisse invenit ? En ideo Casum plane mirandum.

Viginti abhinc Annis Penis cujusdam *Cookworthy* ob Luem Veneream, ad modum quasi *Eunuchi Turcici*, resectus fuit : at Vulnus nec probe curavit Chirurgus, nec bene sanavit ; Cicatrice quippe obducta vix ullum Urinae Iter, Urethra pene occlusa. Lotium exinde exiguiissimo Rivulo summoque nisu reddidit ; brevique inter mingendum Cruciatu magnus accessit ; pauloque post in media, at suprema, Parte Scroti Tumor parvus, sensim tamen auctus in magnam demum excrevit molem, laevum ad Inguen quasi vergens. Hinc Urinam ejaculandi impotens prorsus factus Stillicidio ejus continuo laboravit. Sed neque hac via, Urethrae scilicet, omnem emulxit ; enatis enim tribus quatuorve in Scroto Fistulis, pars forte maxima Lotij ex hisce defluxit, Pure subinde comitante. At ne sic quidem Tumor, jam durus admodum, vel minime decrefcebat, quinimo increvit usque.

Dira haec inter Tormenta cum per plures jam Annos Miser hic, neglectus omnino, miserrimam pertraxerat Vitam ad nostrum Nosocomium tandem delatus fuit. Ibi mense Julio elapso, quum summo nixu Urinam, solito quod dixit ardentio rem, expellere, Corpus incurvando maxime, contenderet, ingens hic prolapsus

lapsus est Calculus, quem jam Tibi misi ; qui recens, excretus Uncias quinque cum Semisse Ponderis Avoirdupois pendit. Eum mihi propere, quasi monstrum quoddam, mitti curabant Nosocomij Rectores. Rem certe quod debui plane mirabar Hominemque invisebam continuo Lacerum inveni Scrotum, jam minime tumidum, Manum puerilem facile admittens, & ex Urethra Calculum elapsum fuisse deprehendi.

Atqui id forsan haud parum Miraculo adjiciat, quod magnum hoc lacerumque Vulnus Balsamo quodam Terebinthino tantum oblinendo brevi sanum evasit, ni quod parva adhuc pateat Urinae Fistula in superiore Parte Scroti. Atque Misellus Ille, cui ante exercitio- nem. Calculi vix ulla se movendi Potentia, commode jam satis obambulat.

Non ego quidem hunc Calculum in Urethra primitus fuisse enatum autumo, ab ibidem Loci ex arenosa materia concretum maxime. Cum enim parvus forte Calculus, Semen quasi hujus enormis, è Renibus delapsus erat ; & ob Urethram fere oclusam, negato ultra Itinere, in Canaliculo substiterat, Sabulo perpetuum appellente auctus in immensam hanc Molem tandem excrevit.

Plymouth, Id. Febr. 1729-30.

Casus alter perquam rarus ex eadem Epistola.

Peperit nuperrime Domina quaedam Puellulam rite & eleganter satis conformatam, ni quod in regione Lumborum infima eminuerit Tumor, sive Sacculus, Magnitudinis quasi Pugni puerilis ; cujus insuper Pedes ad nates usque retracti Posituram Sartoris incoxantibus exhibuerunt ; nec eos movere ullo modo, aut extendere,

tendere, potuit. Mirum hoc & triste Parentibus visum est, mirum & obstetrici & matronis adstantibus : meum ideo protinus Consilium petunt.

Tumorem hunc perlustrando eum ejusdem esse Generis cum illis, quos Tulpius, Cap. xxix, & xxx. lib. III. observat. Descripsit suspicabar : istum ideo Fomento aromatico & adstringente foveri jussi. Intra Triduum autem sero summe adeo distentus evasit, ut jam extrema Tumoris membrana disrupta fuisset ; metusque esset, ne rupto confestim Tumore, Serum semel & simul cum ipsa vita efflueret. Punctiunculam ergo suasi, ut Lympha sensim emitteretur, edito nihilominus Prognostico, sive aperiretur Tumor sive non, eum fore lethalem.

Infans interea insomnis & ejulans parum dormivit, ad Pulticulam vero satis apta.

Quarto adeo Die Tumorem aperuit Chirurgus, facto largiore paululum quam consuluissem *Orificis*, ita ut omnis intra Horas viginti effluerit Humor. Hinc Languor summus & frequens Deliquium ad Biduum saltem ; at nutrice sana & Julap. Cardiaco, Cephalic. refecta viceissimum ad usque Diem Vitam perduxit, quo frigidi Sudores & Tremores aborti tremulam hanc Lucem extinxere.

Inciso Corpore observavimus Dorsalem Medullam ad ultimam Lumborum vertebra, nec ultra, pertingisse ; sed hanc inter & os sacrum (si mavis primum os sacrum) exeuns per Tumoris sive Sacculi membranas dispersita fuit. Os sacrum porro fuit solidum penitus, nec Propagines nervosas Medullae spinalis (quibus apud Anatomicos Cauda Equina Vocabulum est) ad Crura Pedesque transmisit ; quinimo ne quidem perforatum fuit omnino.

In quibusdam saltem a Tulpianis Historiis supracitatis differt haec nostra : neque enim aliquid matri praegnantem negatum neque vel se lectu aut Foetum Imaginatione laeserat unquam, neque Spina hujus Infantis bifida aut lacera : quin etiam nec os sacrum solidum, nec Pedes contractos & immotos meminit Tulpius. Quandoquidem ergo singulare quid habeat haec nostra Historia, hanc ego transcripsi.

II. *An Account of the Imperial Salt-works of Söowár in Upper Hungary, translated from the Dutch of Ernest Bruckman of the Academy of Brunswick, M. D. communicated by Sir Hans Sloane.*

Söowár is an *Hungarian* Word (which signifies in *German* Salt-burg) composed of *So*, which is to say Salt, and *Wa*, which signifieth Burgh or Town. It is a large Village, about a Quarter of a Mile from *Eper*, a City of the County of *Saár* entirely peopled with Officers of the Excise, and Miners or Wood-cutters, and is situated on the Summit of a little Hill, with an agreeable Prospect.

The 16th of *July* 1724, we came from *Rosenau* to *Söowár* with Dr. *Poeckin*, Physician to the City and County, to view this celebrated Salt-work, which furnishes the finest and most pure Salt of the whole Kingdom. We communicated our Intention to an Officer of the Salt-works, and having asked his Leave to go into the Cuts, he gave us two Guards for Guides. We first descended with them into the Well by a Rope,

leat-

feated on *Leathern Dogs* (as they term it) about forty Fathom deep ; after which we again descended one hundred Fathom, by holding ourselves perpendicularly against the Wall and Sides of the Wells ; and having again continued our Journey under Ground in the Salt-work ; we then found ourselves in the Cuts, and saw all the Allies cut in the finest Rock-Salt ; in the midst of which there were here and there some Veins of Flint of a dark Grey. The Miners work to cut this Rock-Salt, which they draw up by a Rope, and put it into a Reservoir, where they cleanse it with Salt-water. They boil it afterwards with the same Water, until it becomes of the Consistence of Cryстал, and then put it into Vessels, which contain about 268lb. Weight each, and then send it into *Silesia* and other Countries.

In regard to the Vegetable or Fossil Salt, it is extremely white and transparent ; it is in such Plenty in the Salt-works of the County of *Marmar* near *Transylvania*, where there are large Mountains entire of Salt, that one might furnish the whole World, in regard to the great Quantity ; as also, because as soon as you cut it, it grows again a-new in a very short Time. They break and cut it, and although it appear at first black, nevertheless in pounding it becomes extremely white : And so it is with that which they use themselves in *Hungary* (for they send all the Salt of *Sórowár* into Foreign Countries.) You find almost in every Inn, two Stones like to those used to make Mustard, between which they pound and break that Sort of Rock-Salt ; and one finds also in their Stables, large Pieces of that Mineral, which the Cattle lick at Pleasure.

But

But to return to the Salt of *Sóowár*, one finds sometimes in the Cuts, Allies of Rock-Salt of the most delicate blue and yellow Colours: We observed, that of the first Colour being exposed to the Sun for some Days, lost entirely all that beautiful Ultra Marine, and became white as the other Rock-Salt, which did not happen to the Yellow, which preserved its Colour; but when you pound them both together, the Salt was neither Blue nor Yellow, but produced a Salt extremely White.

Melissantes in his new Geography, Page 228, speaking of Salt-works, which the *Spaniards* have in *Catalonia*, says, that there is Rock-Salt, the Colour of which is so diversified, that it comes near the Rainbow, in having green, red, yellow, and blue Colours, but that by first preparing, and then grinding it, it became white. The same Thing happened also to the red Rock-Salt of *Saltsburg*, which being pounded became White.

There is in this Mine one very remarkable Thing, that is, a Chapel, which is able easily to contain a hundred People, cut in the Rock-Salt, with an Altar, a Pulpit, a Sacrifty, Chairs, and Forms cut in the same Rock. They celebrate once every Year, the Week after the *Epiphany*, Divine Service in this Chapel. It is always a Jesuite of *Eper* who preaches the Sermon. This Service was founded for the Officers of the Excise, and the Miners.

There is in these Cuts, four Fountains of Salt Water, which they put into Buckets made of Buffalo's Skins sewed together, and draw it up by an Engine worked by Horses, and convey it by Pipes into the Boilers, where they put the Rock-Salt to dissolve,
which

which they afterwards boil till it becomes like Crystal. By exprefs Mandates of the Emperor, no one can sell that Fossil Salt, neither can the *Hungarians* employ it for their own Use, much less drive any Trade in it, but they boil it all, and export it into foreign Countries.

They find here also a Sort of Crystallized Salt, like to the Crust sticking to the Pipes of Wood: The Miners call it Salt of Crystal; it is very white and transparent, but this appeared to us, nothing else but Salt falling Drop by Drop in its Passage in the Pipes, and so crystallizing, which they easily also separate.

But that which is most curious and remarkable in these subterraneous Fosses, are the Flowers of Salt which grow as the Beard of a Goat, with this Difference only, that these here are much whiter, and much finer. One cannot enough admire these Vegetables, yet one cannot find them in all the Cuts, nor at all Times, but they appear and grow according to the Temperature of the Seasons, which in those Parts is very wholesome, and without any thing noxious. These Sort of Plumes of Salt are very brittle, they melt also in moist Places, and dissolve into an evaporated Oil, but are nevertheless the most pure Salt, the finest, the most acid, the most white, and most beautiful; so that it is not without Reason they have given it the Name of Flower of Salt.

The Salt of *Sóorvár* is esteemed the best of all *Hungary*, the greatest Part of which they export into *Silesia*, *Moravia*, and *Bohemia*, and the *Hungarians* dare not use any of it themselves, under Pain of Banishment. They make every Year about 50,000 Tun, every Tun containing 268^{lb}. but by an Ordonnance

donnance of his Imperial Majesty, they will henceforward boil about 100,000 Tun, which they will export as the other. *Martin Zeiler*, in his Description of the Kingdom of *Hungary*, Pag. 119, makes but slight Mention of these rich Salt-works.

In fine, we saw at *Neusol*, at Mr. *De Neßzerus*, Receiver of the Emperor's Rents, a Statue of Rock-Salt as large as Life, which serves as the Barometer of *Neusol*; for when it begins to sweat, or grow moist, it presages Rain, or wet Weather; but when it is dry, you may certainly promise yourself settled fair.

After having employed three Hours to view these Salt-works, we ascended again by the upper Opening, by a common Rope, and returned to *Eper*, where we were civilly entertained by Mr. *Topprener*, one of the most knowing Men in all *Hungary*, Rector of the *Lutheran Academy*, who understands and speaks ten Languages in Perfection.

III. *The natural History of Cochineal; being an Account of a Book entituled, Histoire naturelle de la Cochinelle justifiée par des Documens authentiques Amsterdam, 1729. By W. Ratty, M. D. R. S. Secr.*

A Dispute arising betwixt the Author (*Melchior de la Ruuscher*) and a Friend, concerning the Substance of Cochineal, the one maintaining it to be a small Animal, the other the Fruit, or Grain of a Plant, the Author took the Pains to procure from
Antiquera

Antiquera in *New Spain*, the Place where there is the greatest Traffick for it, the Attestations upon Oath of eight Persons who have been immediately employed in propagating and managing it for many Years; from whence the whole Natural History of this Drug is collected. These shew, *First*, in Regard to *Cochineal* it self,

That they are small living Animals with a Beak, Eyes, Feet and Claws; that they creep, climb, seek their Food, and bring forth Young, not changing their Species as Silk-Worms, but producing their Like; which are not larger than Nits, or small Mites, or the Point of a Needle; but when come to Maturity, resemble in Size and Figure a Dog's Ticke. Thus far is certain, but their Manner of Generating is doubtful, though it is commonly believed by those who cultivate them, that they are impregnated by a small Butterfly, which is bred upon the *Nopal* (the Plant they live upon) which passes and repasses over them

Secondly, As to the Manner of raising, nourishing, and managing them, it appears, that at the proper Time, *viz.* after Winter (when these little Animals can bear the open Air) when the *Cochineals* which they have kept in their Houses are grown so large and big as soon to produce young ones, they put 12 or 14 together into a *Pasfle*, or little Nest made of fine soft Hay or Straw, or Moss of Trees, or the Down which immediately envelops the Cocoa Nut. These *Pasfles* are then placed upon the Plants of the *Nopal*, or Prickly *Indian Fig* (which they take Care to cultivate well for this Purpose) and in 2, 3, or 4 Days, these Animals bring forth a great Number of young ones; soon after which the Mothers die. In the mean

while the young ones, coming out of the Nests, climb up the *Nopal*, fix themselves to it, and suck its Juice, which is their only Nourishment, but don't eat the Plant; and for this Reason, they always seek those Parts of it that are greenest, and fullest of Juice, taking Care at the same Time to place themselves on the Parts most sheltered from the Wind and Weather. During this Time, whilst they are growing up, and become pregnant, great Care is taken that no Vermin incommode or kill them, as also to keep them clean, and disengage them from certain Threads, like Cobwebs, that grow upon the *Nopal*: As likewise to defend them from too much Heat, or Cold; from the Rain and Winds; because the fine Cochineals are very tender: Nevertheless the wild Cochineals stand all these Inconveniencies; but then they are so gritty, of so ill a Smell, and of such little Value, that they ought not to be mix'd with the fine.

Thirdly, In Regard to the gathering of the Cochineal: The first is of the Mothers, which having brought forth their Young, have died in the Nests. Three or four Months after this, as the Season permits, when the first young ones are become sufficiently large and big, and are in a State to bring forth Young in their Turn, and also have produced some few, the *Indians* carefully gather them off the *Nopals* with a little Stick, to which they have fixed a little Hair in the Nature of a Pencil. These Animals being collected in this Manner, and afterwards killed by hot Water or Fire, this is called the second Gathering, or rather the first of the young ones that have been nourished and raised in the open Air. Three or four Months after this, they gather the second
Brood

Brood of those that have been born upon the *Nopals*, which being become big, have brought forth already some young ones. This they do much in the same Manner as before, only now they take off the Plant a great many young ones with their Mothers, which makes this Sort of Cochineal be called *Granilla*, from the Number of small ones found in it. In the mean Time they keep a Number of these young ones alive, upon the *Nopals*, which they pluck up or cut, and lock up in their Houses, to nourish these Animalcules during the rainy Season. *Lastly*, These being grown large, they put them into the Pastles and proceed in the Manner above expressed in the second Article. So that for the most Part they make three Gatherings in a Year.

Fourthly, As to the Manner of killing the Cochineal : This is commonly done two Ways, either in hot Water or in *Tamalescales*, which are little Ovens made for that Purpose, though there are some People who kill them by roasting them upon *Comales*, which are flat Stoves with Fire under them, made use of by the *Indian* Women to bake their *Maiz* Bread. These three different Methods give the Cochineal three different Colours. The first renders them of a brown Red ; the hot Water making them lose the white Colour with which they are covered when alive. The second makes them of an Ash Colour and Marbled, or Jaspered ; both upon Account of the natural White with which they are covered, and the red and transparent Colour of the Cochineal it self. The third Sort becomes black, as if it had been burnt. Of the old ones which died after dropping their young, four Pounds produce but one, when

dried; or rather, one Pound is reduced to four Ounces: But three Pounds only of the living, which have been carefully taken off the *Napals*, being killed and dried, produce as much.

This is the Substance of what I can collect from the Attestations, &c. which are printed and annexed at length, which the Collector says he has done, both as they contain many Circumstances unknown hitherto, both in his own Country (*Holland*) and elsewhere; and as the Curious may be now assured of a Thing which has been very uncertain for so many Years, and indeed known but very superficially, even by those who have embraced the Opinion, that the *Cochineals* were really little Animals. And as there may be always a standing Evidence to evince the Truth of these Facts, he has thought fit to deposite the original Attestations, confirmed by the Certificates of three Magistrates, and three publick Notaries, among the other Registers of the *Royal Society*, by the Hands of Mr. *Eaſt* Surgeon, a Member of our Body. That this therefore may be publickly known, I have, in Pursuance to Order, inserted an Abstract here.

IV. *An Anatomical Description of Worms, found in the Kidneys of Wolves, in a Letter from Mr. James Theodorus Klein, Secretary of the City of Dantzick, F. R. S. to Sir Hans Sloane, Bart. &c.*

I Now lay before you, Sir, some Worms found in the Kidneys of Wolves, to which we commonly give the Name of Vipers. Of these one may read in divers Places of the *Curiosities of Art and Nature*, collected at *Breslaw*. They were sent to me from *Sewaldia*, in *Eastern Prussia*, the Estate of a Gentlewoman named *Madam Roze*.

The first P L A T E.

Fig. 1. exhibits a female Worm found in the Kidney of a the Wolf.

Fig. 2. The Kidney of a Wolf, resembling a Bag, on Account of the almost entire Consumption of its *Parenchyma*. It contained eight Worms, some of a yellowish, others of a Blood Colour; *two* of which were *Females*, *six* *Males*.

Being desirous to see the Dissection of these from the Bag, I sent for my good Friend, the most learned and ingenious *David Kade*, M. D.

The Dissection of each Sex is shewn in

The second P L A T E.

The *Females* were more than twice longer and thicker than the *Males*. They were furnished with three very visible Holes; the first of which perform

ed the Function of the Mouth ; the second of the *Anus* ; the third of the *Tubus*. This last Hole is seen under the Belly, about 1 $\frac{1}{2}$ Inch from the Mouth. (*Fig. 1. a, b, c.*)

The membranous Skin was marked with annular Fibres, and 7 or 8 Chestnut-coloured Lines (*Fig. 1. d.*) running the whole Length of the Worm. The Skin being cut, a limpid Humour issued forth, and then appeared the transversal Fibres interlaid on every Side with the *Viscera*, and are all round about inserted into the Skin in the Interstices of the *Vesicles* (*of which hereafter*) and at the same Time the *Viscera* appeared, which the *sole* Parts destin'd for *Nutrition* and *Generation* seem to make up.

As to the first, or alimentary Passage, it is composed of two Canals, one whereof (*Fig. 2. b, b.*) which begins at the Mouth, and is about 2 Inches long, smooth, fleshy, whitish, and endow'd with thick Coats, serves for receiving Nourishment. As this Duct proceeds with equal Thickness, it is once reflected and retorted before it enters the other (*Fig. 2. c, c, c, d.*) which is of a dark brown Colour, much broader and tenderer than the first, flatted, membranous, covered with very fine Coats, wrinkled like a *Swathing Cloth*, then runs into transversal and winding Sinews, and extends in a strait Line to the *Anus*. The inner Coat of this Canal seemed somewhat rough, and as it were strew'd with Dust. The contained Liquor was perfectly fluid, and of a faint sooty Colour.

But the Organs of Generation we found thus. Near the *Anus* was fix'd to the Skin, the End of a whitish tender Vessel, which thence proceeded strait to the Beginning of the alimentary Canal, where reflecting

flecting towards its Origin, and again resuming its first Way, after being contorted and implicated in many and various Windings and Curves, widens and straitens here and there, until at length becoming more and more capacious, it forms a little Bag, for which a whitish, fine, smooth Canal, about an Inch long, covered with pretty thick Coats, piercing thro' the Skin $1\frac{1}{2}$ Inch from the Mouth, prepares an Outlet, marked under the Belly with a Caruncle (*Fig. 1. c. Fig. 3 and 4. b.*) This little Canal may be, not improperly, called the *Oviduct* or *Vagina*.

The Colour of these Parts is not every where the same; for of whitish at the Beginning, in the Progress it insensibly becomes darker: And at length, where the Vessel acquires a greater Volume, and especially where it stretches forth into the Bag, it is of a Chestnut Colour. And as far as this Chestnut Colour continues, the Vessel is thick stuffed with *Myriads* of Eggs, and therefore is to be called the *Ovary*.

The Eggs, whose Number is certainly incredible, seen with the naked Eye, resemble a *Magma* of a brown Colour; but viewed through those Microscopes, which in the *English Apparatus* bear the second and third Number, they are of the Figure marked *a* and *b* in *Fig. 5*.

The Surface of the inner Skin which inclosed the abdominal Contents, was all beset with small whitish Bladders, of different Figures and Bulks, pouring out a Lymph upon tearing them. These were in the Females.

Though the Integument of the *Male* be marked with annular Fibres, and as many Chestnut-coloured Lines as that of the *Female*, throughout its whole Length,

Length, yet his external Shape differs from that of the *Female*, *First*, Because, as I have already said, he is much less. *Secondly*, Because, the third Hole, *viz.* that under the Belly, is wanting in the *Male*. *Thirdly*, Because the *Anus* of the *Male* is surrounded with a thick cartilaginous Membrane, of near an orbicular Figure, about a Line broad, externally convex, internally concave; on the Middle of which appears a Tubercle, divided by a fine Slit, which lets out the Excrements and a very small capillary Process (*Fig. 6. k*)

The Cavity of the Belly contained a limpid Humour, the transversal Fibres, the alimentary Canals, and spermatic Vessels.

The alimentary Passages had the same Situation and Structure as in the *Female*; the anterior Canal was of a whitish Colour, the posterior, or wrinkled one, of a pale brown.

The spermatick Vessels were very white and slender, yielding, when wounded, a milky Humour. They are divided into two small Branches, hanging out of a vermicular Process (scarce an Inch long) which lies in the Belly, in that Place where the alimentary Canals are joined together, and leans on the Side of the wrinkled Canal, by the Help of the transversal Fibres. These Branches, in their Progress hence, creeping above and below the Canal of the Aliments, are very often reflected, intorted and folded; one at length freed from its Windings, stretches away strait towards the *Anus*, into which it is inserted in the Shape of a pretty stiff Vessel; but the other, at the Side of the wrinkled Canal, being pressed, collected, and equally inflected, almost through its whole Extent,

tent, by the transversal Fibres, ends in the opposite Side, by an Extremity pendulous in the Belly, not far from the *Anus*.

The inner Coat of the Skin, just as in the Females, is all covered with small whitish Bladders, turgid with Lymph, but less, in Proportion to the lesser Bulk of the Worm.

Moreover, we found under the wrinkled Canal a certain whitish Duct expressed in *Fig. 7*, and marked with the Letters *b, b, b*, firmly connected to the aforesaid Intestin by its finest Part; but whose Outlet or Origin, the Tenderness of the Intestin, and Fineness of the Duct hindred us from tracing with Exactitude.

So much I humbly beg, Sir, you'll not take amiss. Furthermore, 'tis great Pity that the excellent Work of the most illustrious Count *Marilli*, of the History of the Sea, was so inaccurately printed. We have thought it well worth our while, not only to make the Corrections and Additions it wanted, but also to draw up an Index of its Contents, which we intend for our own more commodious Use of that Book. To these I add an Example thereof: And if it proves acceptable, you may expect, at a proper Time, the Fruits of another Labour, perhaps not less useful.

It remains to wish you all Prosperity, and assure you that I am, &c.

*From my Study in Dantzick,
Decemb. 3d, 1726.*

The EXPLICATION of the Figures of the second Plate, drawn according to their natural Bigness.

Fig. 1. The Shape of a Female Worm ; *a*, the Mouth of the Worm ; *b*, the *Anus* ; *c*, the *Vulva* ; *d*, the Chestnut-coloured Lines running along the Worm's Length.

Fig. 2. *a*, the Worm's Mouth ; *b*, the alimentary Canal, which is white, carnous, &c. *c*, the alimentary Canal, which is brown and flatted, and whose Extremity is in the *Anus* ; *d*, the Place where the Canals join ; *e, e, e*, the transversal Fibres ; *f*, the *Anus*.

Fig. 3 and 4. *a*, the Worm's Mouth ; *b, b*, the first alimentary Canal ; *c, c*, the latter alimentary Canal ; *d*, the Place where these two Canals cohere ; *e, e, e*, the transversal Fibres ; *f, f, f*, the white Vesicles turgid with Lymph, with which all the inner Skin is thick beset ; *g*, the *Anus* ; *h*, the *Vagina* ; *s*, the *Oviduct* ; *i*, the Outlet of the *Vagina*, or the *Vulva* ; *k, k*, the Ovary fill'd with innumerable Eggs ; *l, l*, the preparing Vessels.

Fig. 5. The Eggs viewed though a Microscope ; *a*, through the Microscope, N^o. 3 ; *b*, through the Microscope, N^o. 2.

Fig. 6. A Male Worm ; *a*, the Mouth of the Worm ; *b, b*, the whitish alimentary Canal ; *c, c*, the wrinkled Canal of the Aliments ; *d*, the vermicular Process of the

the spermatick Vessels ; *e, e*, a Branch of the spermatick Vessels along the Side of the Intestine, compressed by the transversal Fibres, and inflected through its whole Extent in an uniform Manner ; *f, f, f*, the Windings and Turnings of the spermatick Vessels ; *g, g*, the transversal Fibres ; *b*, the cartilaginous Membrane surrounding the *Anus* ; *i*, the small Slit in its Middle ; *k*, the very fine capillary Process ; *m, m*, the small Bladders covering the Skin.

Fig. 7. A Male Worm inverted, and dissected about the *Anus*, in Order to see with Ease the Duct lying under the alimentary Canal ; *a*, the wrinkled alimentary Canal ; *b*, the whitish Duct under the wrinkled Canal ; *c*, the spermatick Vessels.

Fig. 8. *a*, the vermicular Process of the spermatick Vessels ; *b, b*, the Branches of the spermatick Vessels, freed from their Windings ; *c, c*, the same Branches dissected.

V. *Some material Observations upon dissecting an Ostrich, made lately by Mr. Ranby, Surgeon to his Majesty's Household, and F. R. S.*

ABout five Years ago, I laid before the Society some Observations made in an Ostrich dissected, by Order of Sir *Hans Sloane*, Bart. to which Account I beg Leave to add two or three more Observations which escaped my Notice in my former Dissection. And *First*, the Eye, the Figure of which, when

taken out of the Orbit, I think particular, being almost triangular, with some little Variation in the Bony Scales, from that in *Phil. Trans.* N^o. 386. The Contents of the Stomach were of such a Kind, that they were hardly capable (without very great Alteration) of passing the lower Orifice, which is very small.

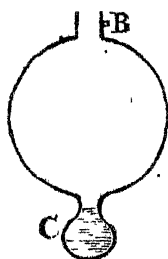
The Diameter of the *Duodenum* much smaller than any of the Intestines, and free from *Valves*, as are the *Jejunum* and *Ileum*, except the latter, which has a few *Valves*, as it approaches near the *Colon*. The *Colon* was uneven, with very regular Cells: These Cells were formed by *Valves*, which were on the Inside, and transversely situated, each making more than half a Circle.

The Parts in other Respects answer the Description given by the several curious Gentlemen that have dissected this Animal.

VI. *A new Kind of Hydrometer made by Mr. Clarke, and communicated to the Society by J. T. Desaguliers, L. L. D. F. R. S.*

THE Hydrometer, by some called Areometer, is an Instrument commonly made of Glafs; as represented by Figure 1, consisting of a Stem A B, graduated by small Beads of Glafs of different Colours, stuck on the Outside, a larger Ball, B, quite empty as well as the Stem, and a small Ball, C, filled with Quicksilver before the End A, was hermetically sealed, in such Manner as to make the Hydrometer sink in Rain Water as deep as *m*, the Middle of the Stem. Such an Instrument does indeed shew the different specifick Gravity of all Waters or Wines, by sinking deeper in the lighter, and emerging more out of the heavier Liquors; but as it is difficult to have the Stem exactly of the same Bigness all the Way, and if it could be had, the same Instrument would not serve for

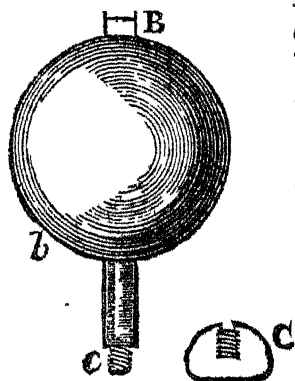
Fig. 1.



Water and Spirits, sinking quite over Head in Spirits when made for Water, and emerging in Water with Part of the great Ball out, when made for Spirits. The Hydrometer has only been used to find whether any one Liquor is specifically heavier than another; but not to tell how much, which cannot be done without a great deal of Trouble, even with a nice Instrument. The Hydrostatical Balance has supplied the Place

Place of the Hydrometer, and shews the different specific Gravity of Fluids to a very great Exactness. But as that Balance cannot well be carried in the Pocket, and much less managed and understood by Persons not used to Experiments, Mr. *Clarke* was resolved to perfect the Hydrometer for the Use of those that deal in Brandies and Spirits, that by the Use of the Instrument they may, by Inspection, and without Trouble, know whether a spirituous Liquor be Proof, above Proof, or under Proof, and exactly how much above or under: And this must be of great Use to the Officers of the Customs, who examine imported or exported Liquors.

Fig. 2. *m*



After having made several fruitless Trials with Ivory, because it imbibes spirituous Liquors, and thereby alters its Gravity, he at last made a Copper Hydrometer, represented by *Fig. 2*, having a Brass Wire of about $\frac{1}{4}$ Inch thick going through, and soldered into the hollow Copper Ball, *Bb*. The upper Ball of this Wire is filed flat on one Side, for the Stem of the Hydrometer, with a Mark at *m*, to which it sinks exactly in Proof Spirits. There are two other Marks, *A* and *B*, at Top and Bottom of the Stem, to shew whether the Liquor be $\frac{1}{10}$ above Proof (as when it sinks to *A*) or $\frac{1}{10}$ under Proof (as when it emerges

ges to B) when a Brafs Weight, such as C, has been screwed on, to the Bottom at c. There are a great many such Weights of different Sizes, and marked to be screwed on, instead of C, for Liquors that differ more than $\frac{1}{10}$ from Proof, so as to serve for the specifick Gravities in all such Proportions as relate to the Mixture of spirituous Liquors, in all the Variety made Use of in Trade. There are also other Balls for shewing the specifick Gravities quite to common Water, which makes the Instrument perfect in its Kind.

VII. *An Account of an Aurora Borealis attended with unusual Appearances, in a Letter from the Learned Mr. G. Cramer, Prof. Math. Genev. to James Jurin, M. D. and F. R. S.*

I Have been so overcharged with Business since I came here, that I had hardly Time enough to think of writing.

Being now a little more at Leisure, I would not miss the Occasion of an *Aurora Borealis*, which appeared here the 15th of Feb. N. S. accompanied with some Circumstances rare enough to be worth your Consideration.

The *Aurora* it self had nothing extraordinary ; it was a quiet one, that is, without any sensible Motion, except, perhaps, an alternative Increase and Diminution of apparent Altitude. Whether it was for this Reason, or because the Light had its Edge imperceptibly confounded with the Colour of Heaven, several People judged of that Altitude severally. There are some
that

that pretend to have seen it to the very Zenith: I was not so happy, and could not see it higher than the Girdle (β) of *Cephus*, which was about 30 Deg. high. The greatest Part did fix it to the Polar Star, which is about 46 Deg. Its Base reached from the Head of *Andromeda* and further, to the Shoulder (γ) of *Bootes*, and further, and so it did insist upon an Arch of 140 or 150 Deg. of the Horizon. This Measure was taken half an Hour after Eight. Its Middle declined from North to West about 15 Deg. The Light was still, and clear enough to read a Character no bigger than that of this Letter. The Base has seemed obscure to some People.

But what was chiefly to be considered, was a great Meridional Zone pretty like a Rainbow in its Figure, but broader. It was terminated by two parallel Arches. The superior insisted with one Side upon the true Point of East, and with the other upon the Point of South-west, or West-south-west: Whence you see its Middle declined about 15 Deg. from South to East, and was diametrically opposed to the Middle of the *Aurora Borealis*. Its Altitude did vary a little, but never reached higher than the Head of *Orion*, which was 54 Deg. high, and never was seen lower than a little under *Procyon*, which is an Altitude of 45 or 46 Deg. The inferior Arch was exactly parallel to the superior, and the Breadth of the Zone varied from 14 or 15 Deg. to 18 or 20 Deg.

The Colour of this Zone was Red, Scarlet, inclined to Purple, pretty lively and changcable by Intervals. It was less vivid near the Horizon, and also to the Meridian, where it seemed now and then interrupted. Some Standers by did imagine two great Arches rising,
one

one from the East, the other from the South-east, and meeting together near the Meridian, but immediately afterwards parting one with another, and drawing back, which they repeated very often.

Under this Zone then was to be seen, but not constantly, one or two Arches lucid and interrupted, which comprehended with the Horizon a dark Segment very like a Mist.

The Phænomenon did last till Four o' Clock in the Morning. The Weather was calm, serene, and cold, the Barometer very high; no Cloud in the Heaven.

It was remarkable, and I think extraordinary, that this *Aurora* considerably darkened the Light of those Stars which were seen through it; and that was much more true of the red meridional Zone, which dyed with its reddish Colour the Stars that appeared behind. When that Zone was the highest, it covered *Jupiter*; and some Gentlemen, which at that Time had not yet remarked the *Aurora*, looking at *Jupiter* through a Telescope, affirm they could hardly see it, but that it seemed as intercepted by some dark Cloud; and indeed it looked at that Time as if it had been seen through a red Glass.

This Observation confirms what is moreover very probable, that this Zone was produced by the Light of the opposite *Aurora*, either by Reflexion or Refraction. But the Manner of its Production seems difficult to be accounted for. There may be supposed Icy Particles swimming in the Air, and of such Figure as to exhibit a great Zone, by the Reflexion and Refraction of the Light of the *Aurora*, almost in the same Manner as the Drops of Rain produce the Appearance of the Rainbow. But this being meer Conjecture, I shall pass it over.

The *Aurora* and *Zone* seemed a great deal nearer one another in the Horizon than in the Top. If we could suppose this Difference to be entirely Optick, and these two Circles really Parallels, that would be enough to compute the Distance of the Phenomenon from the Earth. But the Supposition, though it seemed, at first, pretty allowable, is by no means to be admitted; for it would follow, that the Phenomenon was at least distant from us one twenty-fourth Part of the Diameter of the Earth, which is too great an Altitude to be believed.

I have seen lately another Phenomenon of a quite different Kind. A Friend of mine having caused some Pipes of Ash-tree Wood (that brought Water to his Fountain during at least twelve Years) to be taken out of the Earth, they were left in a Yard not paved, where they rotted almost entirely: But in their room there did shoot forth from the Earth, a little Forest of Ash-trees. They are now in a flourishing Way, and about 3 or 4 Foot high. It is remarkable, that more than fifty young Trees are sprung up exactly where the Pipes had been laid, and no where else in the Yard. There is no Ash-tree there about, nor perhaps at a very great Distance, the Yard being in the Town.

I am, with great Esteem and Respect,

Geneva, Febr. the 20th,
1730, N. S.

Your most humble,

and most obliged Servant,

G. C R A M E R.

VIII. An

VIII. *An Account of a Spiritus Vini Æthereus, together with several Experiments tried therewith: By Dr. Frobenius, F. R. S.*

I. **T**HE Æther of Plants appears to be almost destitute of all gross Air, from placing it under the Receiver of the Air-pump; for exhaust the Air ever so accurately, this Ætherial Liquor remains unmoved, nor does it emit any Air-bubbles which immediately arise in other Liquors, and according as their Quantity of intrinsic Air is greater, so much the sooner are such Liquors put into Agitation, and emit also more Froth, and more vehement Ebullitions in Proportion to Viscidity.

Hence it follows, that this Æther may be preserved best (because without any Diminution) under the Receiver in *Vacuo*, whereas on the contrary, exposed to the open Air, its Parts soon evaporate, and its whole Bulk, but not compressed by the Air, vanishes. (*This Experiment fail'd remarkably.*)

II. A little of it poured on the Surface of the Hand, affects it with a Sense of Cold equal to that from the Contact of Snow, and blow upon it but once or twice with your Mouth, immediately your Hand becomes dry. Beware however of approaching a lighted Candle with your Hand thus wet, lest it take Fire and burn you. (*Succeeded.*)

III. It causes such a Stridor and Hissing, poured upon hot Water, as is frequently occasioned by a Piece of hot Iron thrown into it. Take a Lump of Sugar, imbibe some of this Æthereal Liquor, and put it into

a Vessel full of hot Water, the Sugar will indeed sink to the Bottom, but the Æthereal Liquor rushing violently forth, excites a great Ebullition in the Water. Moreover, if one Spoonful of this Æther be poured into a Copper-Pot-full of boiling Water, without any Sugar in it, and approach immediately with a Candle or a lighted Paper, instantly there issues forth from the Water very great Lightning. The Handle of a Spoon, as well as the Tongs for holding and applying the lighted Paper, must be of a proper Length, that the Effusion of the Æthereal Liquor upon the hot or boiling Water, and the Application of the lighted Candle or Paper may be performed at the same Time; otherwise the Æther is immediately dissipated, without any such Effect. “ There is therefore Need of
 “ an Assistant, or of both Hands, and also of a Room
 “ where Entrance may readily be given to fresh
 “ Air, proportionable to the Magnitude of the Flash
 “ of Lightning which so rarifies the Air as to endanger the Stoppage of Respiration. (*Succeeded.*)

IV. Hence it appears, that this Æther is both Fire and a very fluid Water, but so volatile as it soon evaporates, and that it is the purest Fire; insomuch, as if kindled in a thousand Times the Quantity of cold Water, it burns inextinguishably. Wherefore, if you take an earthen Vessel of any Magnitude, whose Mouth or Orifice may be one or two Yards wide, but the inferior Latitude of the Vessel may contain 600, or 6000 Gallons of Water, the Experiment will be the same, pour on the Top but one Ounce, or a small Vial full of this Æther, and apply to it a lighted Wax-candle, it takes Fire immediately, burns placidly, and is so far from being extinguished by the
 most

most profuse Supereffusion of common Water, that it much encreases the Vehemence of the Flame, and lasts till the subtil Parts of the Æther are consumed and ventilated by the Flame. This Experiment should be made in a large and lofty Room, not in Danger of taking Fire. (*Not shewed.*)

V. The Sense of Touch does not manifest the least Oiliness or Fatness in this Æthereal Liquor, notwithstanding that it is the true, natural, and only Dissolvent, or Menstruum of all Fat, Oil, Rosin and Gum whatsoever: By means whereof all Sorts of Fat, and every Kind of Fire or Flame is extricated by a speedy, safe, and pleasant Operation. On these Accounts it is that this Æthereal Liquor will not unite with any Kinds of Salts whatsoever, but all Sorts of Oils, Pitch, Turpentine, Opobalsams, Camphire, Wax, Ambergrease, Sperma Cete, Mastick, Musk, Copal, and the like, it dissolves most readily, and with the greatest Ease extracts their best Essences.

VI. And indeed a wonderful Harmony is observable betwixt Gold and this Æther, even greater than between Gold and ∇ Regia; insomuch as from hence Gold appears to approach nearer to the Nature of Oils than of Earths, as shall be proved when we treat in their proper Place of the three harmonious Menstrua which we have discovered, *viz.* The corrosive one for the Devoration or Dissolution of Earths, Minerals, and Metals; the aqueous one for the Dissolution of all Kinds of Salts; and lastly, the Æthereal Liquor, or *Oleus Menstruum*. If a Piece of Gold be dissolved in the best *Aq. Regia*, and upon the Solution Cold, be poured half an Ounce, or what Quantity you please of the Æthereal Liquor, shake the Glass
care-

carefully, and all the Gold will pass into the Æthereal Liquor, and the ∇Regia, robbed of all its Gold, will presently deposit the Copper at the Bottom of the Vessel as a white Powder, which turning of a green Colour, contains the Portion of Copper wherewith the Gold was adulterated. The Æther will swim like Oil on the Surface of the corrosive Waters. The Experiment deserves the utmost Attention; for here the heaviest of all Bodies, Gold, is attracted by this very light Æther, or (whereas the Air, which with a common Force presses alike all Bodies, is here excluded, and the Æther it self encompasses and touches the Surface of the Water) the Gold, by the Force of its Gravity, as by an Impulse, would descend from thence; or lastly, this Phenomenon is owing to a certain Harmony and Similitude of both of them. (*Succeeded.*)

VII. Æther then is certainly the most noble, efficacious and useful Instrument in all Chymistry and Pharmacy, *Ubi enim ignis potentialis, ibi actuali non opus est*, inasmuch as Essences and essential Oils are extracted by it immediately, without so much as the Mediation of Fire, from Woods, Barks, Roots, Herbs, Flowers, Berries, Seeds, &c. from Animals, and their Parts too. Thus from Castor, by a certain Manufacture, may be prepared an Oil sweeter than that of Cinnamon, and also the true Oil of Saffron, of wonderful Efficacy; and all by this particular Enchyrrasis, without the Help of Fire or Distillation. For an Example of our Method, take Mint, Sage, or Orange-peels, Cinnamon, &c. or all these together, cut and bottle them, pour upon them a Spoonful or two of the Æthereal Liquor, and after it has stood an

an Hour in a cold Place, fill up the Bottle with cold Water, and you shall see the essential Oil, swimming upon the Water pour'd upon them, easily separable by the Funnel, or *Instrumentum Tritorium*. Of this essential Oil, one Drop only upon a Lump of Sugar, manifests to the Taste, &c. the medical Virtues of the Plant, exquisitely drawn out, comprehended in this Essence, deservedly named *C O S*, as containing the Colour, Odour, and Sapor or Taste of the Plant or Plants. In like manner the essential Oils of Exoticks are easily prepared. (*Succeeded.*) But it is not a true essential Oil, but an excessive strong Tincture, which you may call the Essence.

VIII. Of the like Use it is in the Animal Kingdom, where it produces an essential Oil of *Phosphorus*, as likewise in the mineral Kingdom, though not so immediately, because the Resolution of Earths must precede. Moreover, it is easily proved that the same Liquor extracts the purest Gold, or every Part of the golden System from any, or all the baser Minerals, and that this Gold thus extricated, is by this one Operation better and sooner purified than by Fusion of Minerals with Antimony.

IX. This our Water is neither corrosive nor join'd with apparent Corrosives: Wherefore fill as many Bottles with Æthereal Water as there are Sorts of Salts, and into the first, Drop by Drop distill Oil of Vitriol; put into the Second Spirit of Sea-salt, into the Third Spirit of Nitre, or of Alum, or of Sal Armoniack prepared with Water, or the Lixivium of Tartar, or rectified Wine-vinegar, all the Salts immediately sink to the Bottom: Besides, it is the lightest of all Liquors; for fill any Vessel with twenty Ounces of Oil of Vi-

triol.

triol, the same emptied, will contain but seven Ounces of Æther. It is the very Ens, or Being most pure of Flame; wherefore neither Soot nor Ashes are ever found upon its Deflagration. (*Succeeded.*)

Thus said Dr. Frobenius; but to make this Paper more than a meer Harangue, it is absolutely necessary to subjoin two Paragraphs out of a Paper of that excellent Chymist Mr. Godfrey, (Dr. Frobenius's Fellow Labourer) in these Experiments which he delivered in when this Æther was made publick before us.

“ Feb. 19th, 1729-30. That this Liquor Æthereus,
 “ was formerly very much esteemed and enquired into,
 “ doth clearly appear by an Experiment I made formerly for my worthy Master, Esq; Boyle,
 “ by the Means of a metallick Solution, namely, by
 “ the Solution of crude Mercury united with the
 “ *Phlogiston Vini*, or other Vegetables, and this
 “ Æther swam on Top of the Solution which I separated *per Tritorium*. Note, This is what I have
 “ done formerly in Esq; Boyle's Laboratory, and Sir
 “ Isaac Newton was very well acquainted with it
 “ too; which by reason of Shortness of Life was not
 “ brought to a full End, to do it so readily in Quantity. But when Dr. Frobenius, by Experiments on
 “ this in my Laboratory, did produce it in greater
 “ Quantity, he wanted to see how far Sir Isaac
 “ Newton had gone on with it in his Book. There
 “ we saw that great Man's Application in Fol. 330,
 “ that he had done it *cum Ol. Vitr. & Sp. Vin.*

This

This of Sir Isaac Newton, is the Vini Æthereus, only there is a Difference in the Process : The Liquor Æthereus is made with equal Parts in Measure, not Weight. The upper yellow Liquor is separated from the inardent sulphureous per tritorium. The inferior Liquor is thrown away; and the superior yellow is put into a Retort to be distilled with the most gentle Heat; and the Extraction of the Æthereal Liquid continued so far until the superior Hemisphere feels cold, and the Retort being clapped in the Hand, there is found in the Receiver a Vino-sulphureous Gas. very Æthereal. Let the Sulphur be precipitated by adding an Alkali, and gently throwing it in till all Ebullition ceases, and the Liquor will not farther strike it self against the Hand. but will strangely attract it. Then the Alkali will go to the Bottom of itself, or precipitate it self in the common Water.

P O S T S C R I P T.

I Have purposely omitted giving the Receipt entire, which Mr. Godfrey has done in the next Paragraph; as also Dr. Frobenius in his Paper, because those who would read this Transaction may refer to the Learned Author for it. And as for others who may chance to cast their Eye upon this Paper, they will know where to have enough of it, by reading Mr. Godfrey's last Paragraph.

IX. *An Account of the Hermaphrodite Lobster presented to the Royal Society on Thursday May the 7th, by Mr. Fisher of Newgate-Market, examined and dissected, pursuant to an Order of the Society. By F. Nicholls, M. D. Præl. Anat. Oxon. F. R. S.*

THE World has frequently been amused with Appearances proper to both the Sexes, in Persons who have from thence termed themselves *Hermaphrodites*: But such of them as have passed a more strict Examination, have proved, that those Appearances were either morbid Cases, or præternatural Formations of the Parts proper only to one Sex. Thus an elongated *Clitoris* has passed for a *Penis*, and *scatomatous* (or other) Tumors of the *labia pudendi* have been thought *Testicles*, while the subjacent *Vagina* has been the only Proof of the Existence of the Parts proper to both Sexes in the same Subject. So that at present the Existence of præternatural Hermaphrodites seems universally denied. Nor is it easy to conceive, how an Hermaphrodite can be formed in a Species whereof each Sex has the Parts subservient to Generation, single and necessarily situated in the same Parts of the Body; at least without either a very remarkable Mal-formation of the Body in general, or so perverted a Situation of those Parts, as must very much impair their Uses.

But in those Animals whose Parts of Generation are double and independant on each other, as the Lobster, Crab, and many Birds, the Parts proper to both Sexes may possibly be formed in the same Subject without Prejudice to their Uses: But in that Case the several Parts can be but single; and consequently, the Subject

so formed cannot be termed perfect as to its Species, in regard to either Sex, though it may be perfectly of both Sexes so far as regards Generation.

Under this Idea of an *Hermaphrodite*, I may venture to say, the Lobster referred to my Examination is truly one; and, if split from Head to Tail, is Female on the right Side, and Male on the left Side.

In Order to illustrate this, I shall give a short Account of the Structure of the male and female Lobster, so far as relates to the Difference between the two Sexes, and then proceed to shew in what Manner they were combined in the Subject before you.

It has already been observed that the Lobster, both male and female, has all the Parts of Generation double, except that the female has one Passage only, through which it is probable the *Ova* are emitted out of the Trunk, in Order to be affixed to the small Appendages under the Tail.

The *Penis* of the male Lobster arises from the Testicle, and is no more than a Continuation of the *Vas deferens*; it is reflected and retored once, after which it grows thicker, as to its Substance (probably forming a *corpus cavernosum*) and terminates, not in the last Leg but one, as *Willis*, in his Treatise *de Animâ Brutorum* has observed, but at a small perforated Tubercle in the first Bone of the last Leg. See Fig. the 1st, A A, the two Penes.

Between the two last Legs and the two Legs above them are two Processes, which, from their resembling the *Nymphæ* of Women, I shall term *Nymphæform* Processes. These Processes are covered with Hair, and unite at their Bases without leaving any Passage. Fig. the 1st, B B, the two *Nymphæform* Processes.

Below the two last Legs, towards the Tail, are two Appendages, which, from their Similitude, I shall

term the *styliform Appendages*. These in the Male are thick, hard, and void of Hair. *Fig. the 1st, C C, the two styliform Appendages.*

The Tail is continued from the Trunk in a gradual Decrease of its Dimension, and is covered by Plates, which extend themselves but little below the Substance of the Tail, and terminate in acute Angles, without any Ways diverging. *Fig. the 1st, D D, the Terminations of the Plates.*

It is to be observed, that sometimes these Plates are edged with short and thin Hair, and sometimes have no Hair.

The Female on the other Hand, in the Place of the Testicle has an Ovary, which, like the Testicle, extends itself from the Stomach to near one half of the Tail. From the Middle of the Ovary a Duct descends to the Legs, which opens at a round Hole edged with Hair in the first Bone of the last Leg but two: This is the Uterus. *Fig. the 2^d, A A, the Entrance into the two Vaginæ.*

The two Processes, which I have termed *Nymphæform*, in the Female make a more obtuse Angle at the Union of their Bases; are less hairy, and leave a Passage, through which it is probable the *Ova* are emitted, to be affixed to the Appendages under the Tail. *Fig. the 2^d, B B, the two Nymphæform Processes; D, the Passage for the Ova.*

The two styliform Appendages in the Female are soft, thin, and edged with long Hair. *Fig. the 2^d, C C, the two styliform Appendages.*

The Plates covering the Tail are extended much farther under the Tail than in the Males, beside which they diverge, in order to leave a greater Space for containing the *Ova*; for the better Defence of which they terminate broad, and are edged with thick and long Hair. *Fig. the 2^d, F F, the Terminations of the Plates covering the Tail.*

In

In the *Hermaphrodite Lobster* I found all these Parts proper to both Sexes regularly disposed, but in such Manner that the Parts proper to the Female were to be found only on the right Side, and the Parts proper to the Male only on the left Side.

In the antepenultimate Leg the *os uteri* was very obvious on the right Side, as in the Females, but had not the least Mark of any such Passage in the same Leg on the left Side. *Fig. the 3d, A, the os uteri only on the right Side.*

The *Nymphæform Process* on the right Side made an obtuse Angle at its Insertion into the Body, and was soft and perforated as in the Females, while the corresponding Process made a less Angle, was more hairy and rigid at its Basis, as in the Male. *Fig. the 3d, B, the right Nymphæform Process; C, the left Process.*

The *styliform Process* on the right Side was soft, flat, and edged with Hair, as in the Female; but on the left Side it was stiff, hard, and void of Hair. *Fig. the 3d, D, the right styliform Process as in the Female; E, the left styliform Process, as in the Male.*

In the last Leg on the left Side the perforated Tubercle for the Passage of the *Penis* (as in the Male) was very conspicuous, but without the least Appearance of such Tubercle in the corresponding Leg on the right Side. *Fig. the 3d, (H) the perforated Tubercle for the Passage of the Penis.*

The Plates covering the Tail were extended on the right Side considerably below the Substance of the Tail, and were edged with thick and long Hair, and terminated broad, as in Females. *Fig. the 3d, F, the Termination of the Plates covering the Tail.*

On the left Side, these Plates were much less extended below the Tail; were almost totally void of Hair, and terminated in acute Angles. *Fig. the 3d, (G)*

the

the Termination of the Plates covering the Tail on the left Side.

These Plates diverged likewise on the right Side, as in the Females, but not on the left Side, as in the Males. *Fig. the 4th, A, the diverging of the Plates on the right Side; B, the Plates no Ways diverging.*

Upon removing Part of the great Shell, I found the internal Parts of Generation in both Sexes exactly corresponding to those externally described.

In the right Side adjacent to the Heart, the *Oviduct* was regularly disposed, it was full of *Ova*, and sent off its *Oviduct* or *Uterus*, to the antepenultimate Leg. *Fig. the 4th, F, the Ovary; G, the Oviduct or Uterus leading to the antepenultimate Leg.*

In the left Side the Testicle was rightly disposed as to its Form, Substance, and Situation; Part of which I was obliged to remove, in Order to shew the *Penis*, which terminated as in all Males, at the Tubercle in the first Joint of the last Leg. *Fig. the 4th, E, the Penis; I, Part of the Testicle unremoved.*

I had some Thoughts of removing so much of the great Shell as was necessary to shew the Course and Terminations of the *Uterus* and *Penis*, at their proper Orifices. But considering that by that Means the Tail would too easily separate from the Trunk, and the Appearances of the other Marks be rendered less obvious; I chose only to lay them open at the Back, believing that to be sufficiently satisfactory to those who understand the Structure of that Animal. I have steeped it in three different Spirits, and carefully disposed it in a Glass, which I have stopped in the best Manner I can, that it may remain in the Repository, as an undeniable Proof of so remarkable a Fact.

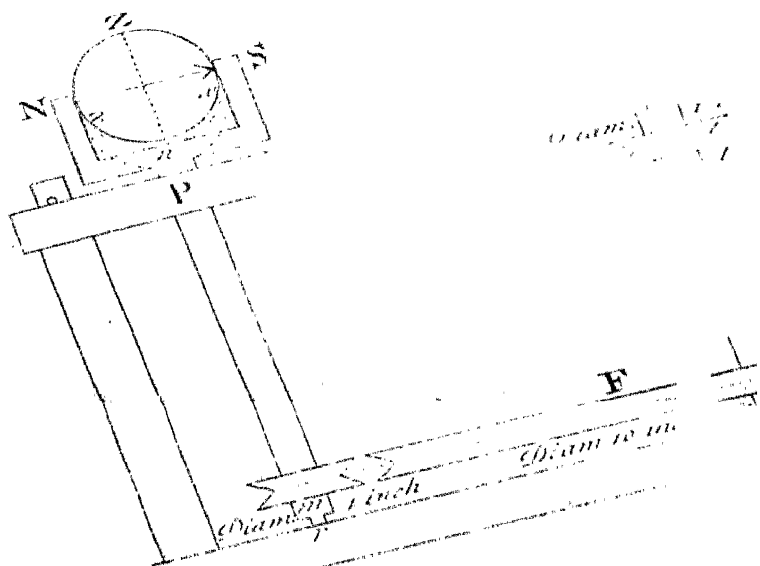
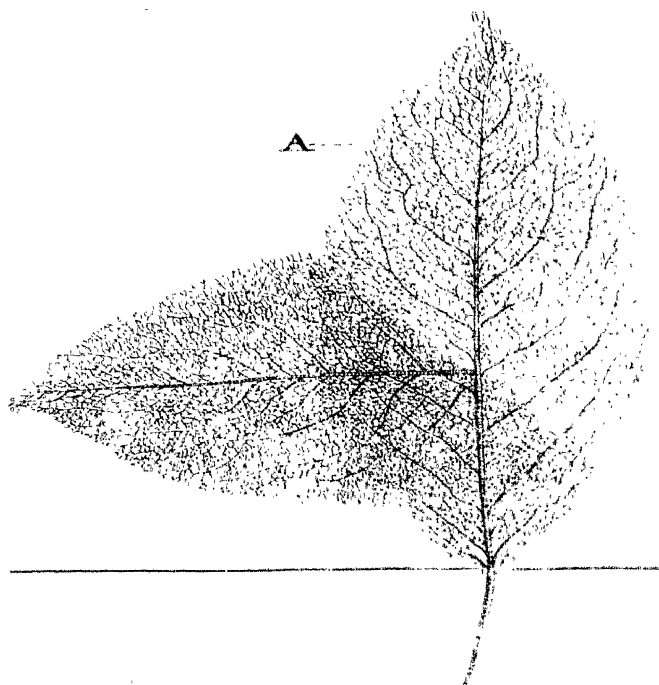


Fig. 11

B



Fig 1.

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *May, June, July* and *August*, 1730.

The CONTENTS.

- I. *Magnetical Observations and Experiments; by*
Servington Savery, Esq; of Shilfton.
- II. *An Essay upon the Use of the Bile in the Animal*
Oeconomy, founded upon an Observation of a Wound
in the Gall-Bladder. By Alexander Stuart,
M. D. Physician in Ordinary to her Majesty,
Fellow of the College of Physicians, and of the
Royal Society.
- III. *Observatio Lunaris Eclipsæ, Ulissipone habita*
die 2 Februarii, An. 1730, N. S. in Collegio
Divi Antonii magni à Rev. P. Joanne Bap-
rista Carbone, Soc. Jcs. Ex ejusdem Cl. Viri
Epistola ad Jacobum de Castro Sarmento,
M. D. Coll. Med. Lond. Lic. & R. S. S.
I V. Ob-

The CONTENTS.

IV. *Observationes Cœlestes Multifariæ inter Menses Novemb. 1727, & Novemb. 1728, Pekini in SINIS habitæ, & ad Rev. P. Joannem Baptistam Carbone, Soc. Jes. transmissæ. Ex eadem Epistola descriptæ.*

V. *An Account of the Veins and Arteries of Leaves.*
By Frank Nicholls, M. D. Præl. Anat. Oxon.
F. R. S.

I. *Magnetical Observations and Experiments*; by
 Servington Savery, Esq; of Shilfton.

P R E C O G N I T' A.

I. **T**HAT which I call the Magnetical Line, is the Position of a Dipping-Needle when it ceaseth from oscillating, and is at Rest in the magnetical Meridian of the Place.

II. By the Word Magnet (unless distinguished) I would be understood to mean not a Loadstone only, but either that, or Iron or Steel, when they have permanent Polarity, or any thing else (if to be found) which has a sensible magnetical or polar Attraction.

III. Of the magnetical Needle, I always call that the North End which (if hung horizontally) naturally turns to the North, and that the South End which turns to the South: But when I use the Words Pole of a Needle, I call that the North Pole thereof which turns to the South, and that the South Pole of it which turns to the North.

IV. Of Touched Iron or Steel (or of Untouched, so long as it remains in a Posture which gives it Polarity) as well as of the Loadstone itself, I call that the North Pole which attracts the North End (*i. e.*) the South Pole of the Needle, and that the South Pole which attracts the South End, or North Pole of the Needle: Or in other Words, I call that the North Pole, in all Sorts of Magnets, which is endued with the same kind of Vertue which the North Pole of the Earth hath, and consequently is repelled thereby: *E contra*, &c.

V. I prepared Nails of several Sizes, from the smallest Sort of Bellows-Nails to the largest Sort of Rafter-Nails, one or two of each Sort, or more of the smaller : I held each of them perpendicularly with its Point upwards, and placing thereon the plain Side of a File horizontally, I filed off a little from the Point thereof (more or less according to the Size of the Nail, perhaps about the Thickness of a Six-pence from a Six-penny one). Then on a plain Hone, held horizontally, I placed the Nail upright, with its Point downward, and so rubbed off the Strokes of the File. Then I rubbed it a little on a Piece of Leather. *Note*, The truer this little narrow Plain is, and more exactly perpendicular to the Nail's Axle, the better.

VI. I prepared Iron Bars of different Lengths after the following Manner : I made each End in the Shape of the lower Frustum of a Pyramid, cut transverse to its Axis about the Middle, or a little higher up. Then I filed the Ends of the Bar as plain and perpendicular to its Axis as I could, and polished them with a Hone, &c. as I did the Nails. *See the Figure.*

VII. One of the Needles I used untouched, for trying Experiments, was made thus : I took some Iron Wire, about the Size of a small Knitting-Needle, and in Length about two Inches and a half. With a Hammer I made it just flat enough in the Middle, to be able to fix the Point of a Punch pointed, to as true a Cone as I could ; its Sides (as I guess) made an Angle with each other at the Vertex of about 45 Gr. or more ; in the Middle of the Wire I punched a Hole at least half

half Way through the Thickness thereof, and wrought the Hole with a Drill (pointed like the Punch) that it might be truly round, and cleaved off the Asperity which the Punch and Drill had raised round the Hole lest it should injure the Top of the Pin when it was placing thereon. Then I bended it in this Form,



taking Care to bend it the right Way, that the Hole might be on the under Side. Then I marked one End, by flattening it a little with a Hammer, that it might be known from the other. Then placing it on a sharp Pin, to find which End was heaviest, I made both alike in Weight, and deprived it of all fixed Magnetism. Then I brought it again to as true a Poise as I could, by rubbing the heaviest End on a Whetstone, and not a File, which might give it Magnetism again. I fitted a Pin for it of brass Wire, full so small as the middle Strings of a Spinnet, making the Point very meagre and round as well as sharp, and observed it frequently with a Lens of two Inches Focus; and if it appeared flat, I mended it on a Hone, and took great Care in putting on the Needle, not to hurt the tender Point of the Pin. I put a Glass over it, to keep off all manner of fanning by the Air, the least Degree whereof did spoil the Experiments.

VIII. A second Needle, which I thought better than the former, I made thus: In the middle of such a Piece of Wire as the former was made of, I wrought a Hole through it as perpendicular as I could to its Axis, or Length, and so small as any of those which are drilled through the Pillars of a Watch, if not small-

ler. And having bended the Wire in this Form,



I marked one End thereof, and drove into the Hole a small brass Pin fitted to it, which was very round and sharp at the Point, which rested on a deep Plano-Concave Lens of Glass well polished. (*See the Figure.*) I fitted a Box for it with a Glass over it; which Glass was fastened with a Ring of brass Wire, as the Glasses of Telescopes are; which Ring kept out Air, otherwise had been needless. The Glass Concave was fixed in the great End of a thin Brass Ferule (like that off a Staff) just fit for it, and the small End of the Ferule was fixed in a Hole made for it in the Middle of the Bottom of the Box: I also put a Ring of thin Brass on the Top of the Lens, not only to keep it in steady, but to prevent the Pin from going in betwixt the Lens and the Ferule, which spoils its Point. Doubtless a Concave of Diamond is much better.

Whensoever I used one of either Sort of these Needles (especially for such Experiments as required it to be perfectly void of fixed Polarity) I was obliged to keep it in a Motion either librating up and down like the Beam of a Pair of Scales, or trembling (which is a short pendulous Oscillation from Side to Side) or else both librating and trembling at the same Time; which said two Motions being at right Angles with each other, are not inconsistent: And if the Needle is truly poised, the horizontal Verticity is neither obstructed nor accelerated by the Librations, because they are at right Angles therewith, nor by the Tremblings, because the two Ends perfectly balance one another in contrary Motion.

tion. The Service they do, is to abate that Friction on the Pin's Point, which retards the horizontal Verticity; for when the Friction is divided between the horizontal Verticity, and the Librations or Tremblings (either of the two latter rolling on the Pin more speedily) the far greater Part of the Friction is spent on the Librations, or Tremblings, and consequently there is but little left to retard the horizontal Verticity. I take such a Needle to be far better for my Purpose than the common ones, which have a heavy Socket of Brass, or Steel, in the Middle, useful only to render them portable, but very detrimental in nice Experiments; because the Weight of the Socket not only blunts the Pin sooner, but also encreaseth the Friction, though the same Acuteness of the Pin should be supposed to continue. To renew the Tremblings when they began to abate, I rarely jogged the Box on the Table, for fear of giving it (and the Needle within it) a circular Motion, which obstructs the Design: But I found it best to do it, by jogging the Table gently. When I had Occasion to turn the Needle to any other Point of the Compass, I elevated that Part of the Box which was under one End, until it rested on the Bottom, and in that Posture could turn it as I would; but before I could let down the Box again to an horizontal Position, was forced to wait till the Needle was very still, and to let down the elevated Side easily, and with a direct Motion; otherwise the Needle, as soon as both its Ends were free, would have more or less of an horizontal Motion.

Most of the known Properties of all Sorts of Magnets which have been discovered by the Observations and Experiments of several Persons, including one or two of my own, are the following.

I. THAT the Loadstone, by an invisible Force which differs from that of Gravitation, and also of Electricity, draws unto itself Loadstone, Iron, and Steel; and with the same Kind of Force, or Power, does not (at least very sensibly) attract any other Body whatsoever.

II. That the Loadstone attracts Loadstone, Iron and Steel with a polar Attraction; and that whatsoever Attraction is not polar, is not magnetical.

III. That the two opposite Parts of a Loadstone attract most vigorously, and are called the Poles thereof. The Middle between its two Poles doth not attract at all, and may be called its *Æquinoctial*; and from either Pole to the Middle, the attracting Force does gradually abate.

IV. That in the same, and every Loadstone, the one of its Poles is in Vertue (or rather in Direction) contrary to the other, and therefore they need to be distinguished from each other; which is done by adding North or South. The North-Pole of one Loadstone will not attract, but repel the North Pole of another, though they are possessed of similar directive Vertue; neither will the South Poles of any two Loadstones attract, but mutually repel one another: But the North Pole of one Loadstone, and the South Pole of any other, do mutually attract each other; and though their directive Vertue is contrary, yet the unknown Cause of their Attraction and Repulsion seems to be the same.

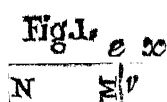
V. That

V. That there is no Difference (at least I could never find it) between the Force or Strength of Attraction and that of Repulsion in the same Pole of any Loadstone or Magnet, unless when a small one approaches so near to a large one, as to have its Polarity more or less diminished thereby.

The preceding Properties convince me, that there is no such thing in Nature as magnetical Attraction without Polarity, which is constituted of Attraction and Repulsion; and these two Powers being always equally strong in the same Pole of every Magnet, I take it to be a plain Contradiction, to say this or that Loadstone has a strong Attraction, but a weak Polarity or Direction.

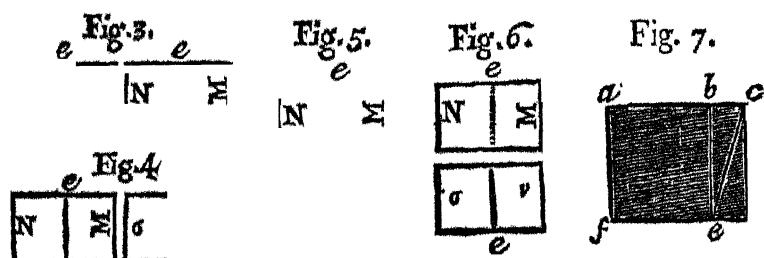
VI. That no interposed Body whatsoever (unless it is magnetical) though the most solid in Nature, was ever known in the least to impede or divert any of the Effects of a Magnet; but it is always found to attract magnetical Bodies full so powerfully at the same Distance, as if nothing at all was between.

VII. That every Frustum of a Loadstone is an entire or perfect Loadstone, having in itself both Poles as the whole Stone had; and that the Poles in each Frustum have their Direction (as near as the Figure of it will admit) in the same parallel Line wherein they were directed both in it and the whole Stone, before it was separated therefrom: For the Polarity of every Fragment is usually, if not always (before they are separated) parallel to that of the whole Stone, and consequently to that of each other: And if ever it is found otherwise, I cannot but think that Loadstone wants of Perfection.



Let $N \Sigma \nu \sigma$, *Fig. 1.*, be a Loadstone in the Form of an oblong right-angled Parallelopipedon, whose Polarity is Length-ways, N being its North Pole, e , the pricked Line, its Equinoctial (or Middle betwixt its Poles) where it has no Attraction, and σ its South Pole. Let it be bisected at e , transverse to its Polarity, or Length. Each of its Frustra (represented *Fig. 2.*) when they are placed too remote to act on each other) will infallibly be possessed of both Poles (with its Equinoctial in its Middle) as the whole Stone was before its Bisection: And though originally the one Frustrum $N \Sigma$ was all over a North Pole, and the other $\nu \sigma$ all over a South Pole, while they adhered to one another, yet now they are divided, and placed beyond the Reach of each other's Vertue, one half of the Frustrum $N \Sigma$ from the Place of its *quondam* Contact Σ , to its Middle e , does instantly become a South Pole, and attract strongly at the Place of Contact afore said, which Attraction is gradually less and less until it is abated to nothing at e . So also one half of the Frustrum $\nu \sigma$, from the Place of its former Contact ν to its Middle or Equinoctial e , instantly becomes a North Pole (gradually abating in Strength from ν to e) though the whole Frustrum, before its Separation from the other, was a South Pole: The Polarity being also directed the same Way in each Frustrum that it was in it (and the whole Stone) before

fore the Bifsection. The Case also would have been the same, if the Stone had been divided unequally at κ , or elsewhere transverse to its Polarity, *Fig. 1 β* , and of each Frustrum, one half would have been a North Pole, and the other half a South one, with its Equinoctial in the Middle as before. The whole Stone will lift a larger Iron than either Frustrum; but both Frustra, while out of the Reach of one another's Virtue, will each of them lift his Iron, both of which Irons will be heavier than what the whole Stone could lift before it was divided. If the said Frustra are again joined close together at the same Ends which originally adhered, *Fig. 1 β* , being as they stand directed towards each other *Fig. 2d*; or if the opposite Ends of both are joined together, as they stand directed towards each other, *Fig. 3d*, I do not see (provided the



Joint is very good, that there may be a Contact all over it so good as a Workman can make) why they should not compose again one entire Loadstone, so good as it was before it was divided, in all Respects (Allowance being first given for the Waste in sawing it asunder, and mending the Joint) and their joined Poles mutually attracting one another, attract nothing else at the Joint (which being in the Middle, would become

its Equinoctial) but transmitting their Vertue through one another, the Pole Σ of the one Frustum, *Fig. 2d*, wholly spends itself in strengthening the similar Pole σ of the other Frustum, by weakning the Pole ν thereof, & *vice versa*. And if their Lengths should be unequal, like the Frusta of *Fig. 1st*, divided at x , the Equinoctial would not be at x , where they were joined together again, but always at e the Middle of their whole conjunct Length, as it useth to be in one entire Loadstone of the same Bigness from Pole to Pole: For I apprehend if any Loadstone should be wrought very Tapering from one Pole to the other, that the Equinoctial could not be precisely in the Middle thereof, but according to what Degree of Taperness it is wrought to, be removed nearer to the great End: But these Things, for want of proper Loadstones, I cannot try, nor yet the following on *Fig. 7th*, which represents a Loadstone in the Form of a Parallelopipedon right angled, in Thickness one Inch, its Breadth af 6 Inches; its Length ac 7 Inches or more, having its Polarity not perfectly length-ways in it, but a little oblique, as the Shade-Lines represent it. If there is cut off from one of it's Ends cd , the Parallelopipedon $bcd e$ one Inch from the said End, it will be one Inch square, and six Inches long: I suppose this lesser Frustum would have its Polarity changed, and the Direction thereof, instead of running from e somewhat towards d , would run from e towards c in the Diagonal Line ec , or in some Line or other between the Lines eb and ec . I also imagine, that if a Cube was cut off, within a little Time after, from one End, the Polarity therein would be directed as it was therein, while all the said Frusta adhered

together

together; but if the lesser Fruſtum *b c d e* ſhould long remain ſeparated from the whole Stone, before the ſaid Cube was cut off, that the Polarity of the Cube would be more or leſs fixed, and conform itſelf more or leſs to the Direction of the Line *e c*. However, this is certain, that if the two Fruſta are joined together, as they ſtand directed *Fig. 2*, or *Fig. 3*, with the North Pole of one to the South Pole of the other, they aſſiſt one another in liſting Iron. If joined *Fig. 4th* with the South Pole of one againſt the South Pole of the other, by repelling they reciprocally deſtroy each other's Vertue, and alſo hinder one another's Attraction at the North Poles, which are not joined. If they are placed together, as in *Fig. 5th*, though they endeavour to avoid one another, yet they do not deſtroy each other's Vertue ſo much as in the preceding Caſe, nor yet at all if there is a perfect Contact: For if this Poſture of two Magnets actually adhering would diminſh their Vertue, one Part of the ſame Loadſtone would deſtroy another Part of itſelf, and in a very ſhort Time there would be no ſuch Thing as Magnetiſm. In this Poſture they mutually help one another's Attraction, becauſe their Polarities are directed the ſame Way. If they are applied, as in *Fig. 6th*, with their Sides together, and their Polarities contrarily directed, the North Pole of the one (at either End) attracting the South Pole of the other, and the South Pole the North, they ſcarcely injure one another's Vertue by ſo lying together, but hinder each other from attracting other Things, by ſpending their Vertue on each other.

VIII. That all magnetical Attraction (as alſo Repulſion) is mutual; for Iron or Steel attract the Load-

stone, as that does Iron or Steel, and they also one another.

IX. That every Loadstone communicates Vertue to Iron or Steel, not only by Contact, but even by an Approach of them within its attractive Sphere, more or less as nearer to, or farther from its Body; and likewise its Poles, also according to the Shape, Bulk and specifick Vertue thereof, and Figure of the Iron or Steel, and their Proportion of Magnitude to one another. I apprehend, that though a great Magnet (I mean of such as are similar in Figure and specifick Vertue) will lift considerably larger Irons than a small one, yet the small one shall give to the same Piece of Steel (provided it is not too large for it to conquer) well nigh (if not altogether, as to Sense) so strong a Touch as the great one. And I have experienced, that if the small one is specifically pretty much better, it will give the same small Piece of Steel a considerably stronger Touch than the great one can, though the great one is capable of lifting perhaps three or four Times so much as the small one. *Note*, That if the great one is so strong as to give the small Piece of Steel so much Vertue as it is capable of receiving (for there is, I suppose, a *ne plus ultra*) that then should the small Stone be ever so much better, it cannot mend the Touch given by the great one. Some write, that the Loadstone loses none of its Vertue by communicating of it to Iron or Steel, which I somewhat doubt the Truth of, especially if the Stone is small in Proportion to the Steel, in which Case I have known touched Steel lose considerable Vertue.

X. That Steel is not only more receptive, but more retentive of Magnetism than common Iron; Iron or Steel

Steel hammered hard, than the same while soft ; but Steel hardened by quenching, than either of them. My Observation has been, that Steel cannot be seasoned too hard for Retention (nor, as I think, for Reception) of Magnetism ; but may sometimes warp too crooked for its intended Use, and must be made right again some Way or other, either with a Grinding-Stone, or (if that will not do) by heating it to a blue Colour, and gently hammering it while hot ; but if it can be helped, the Temper for the blue Colour is too soft.

XI. It has been observed, that oblong Pieces of Iron or Steel applied any how to the Loadstone, receive Vertue chiefly (some say only) as to their Lengths. This was what induced me to explain *Fig. 7th*, in the Middle of *Pag. 304*. For I think it a parallel Case with this here, and suppose that the Vertue may incline to run length-ways even in the Loadstone itself. However, I think if it must be allowed to be length-ways, it is sometimes found to be very irregular in pretty long Pieces, as North Pole against North Pole, South Pole against South Pole several Times in the same Piece, which several contrary Polarities have been observed by several in Wires, and I have seen in a round Bar (of which Irregularity, and the Method of curing it, more hereafter) But such contrary Polarities seem unaccountable.

XII. That such Iron and Steel as has magnetick Vertue communicated to it, does also communicate thereof to other Iron or Steel after the same Manner a Loadstone does. Which Vertue, after never so many Communications, is, as to its Nature, perfectly the same with that of the Stone itself, having both Poles, and

and will touch other Steel, and that a Compass, so well as the Loadstone itself, and so vigorous, if used as hereafter is directed.

XIII. That the Earth contains within it, at or near its Center, a Loadstone or Magnet (probably spherical) large enough very sensibly to affect magnetical Bodies all over the Surface of the Earth. The Poles of its Attraction are considerably distant from those of its own, which are the same with those of the Earth's Diurnal Rotation. This internal Magnet must either be loose from the Body of the Earth, and revolve within it very little slower, or else, if it is fixed to the Earth, the very Polarity itself must have changed its Situation in respect of the said Magnet, One, of which, several recorded Observations in distant Years sufficiently prove. The former seems most probable: However, I imagine (was it not for the Charge and Trouble) an Experiment might be made which would shew whether or no it is possible in Nature for the Poles of the said Central Magnet to change their Situation in respect of itself, as well as of the Earth, as will appear when I give the Description of it.

XIV. That every Loadstone within its attractive Sphere has a Power (the nearer either of its Poles the greater) to keep one Piece of Iron suspended to another, especially if that to which it is suspended is the largest, and their Ends be bright and clean, where they touch one another; and if the suspended Iron is not too heavy, the other will draw it up from either Pole of the naked Loadstone actually touching it, and will also keep it suspended, till at a considerable Distance therefrom; but will not draw it off in
such

such manner from the Armour of unarmed Stone, if the Armour and Iron are both of them bright and clean at their Contact. Hence it must follow,

XV. That an armed Loadstone can lift more with either of its Poles, used singly, than the same can lift naked; and this it will do, though the Armour should be narrow, and touch very little of the Stone; how much more then will it lift, when the plated Part thereof covers all the End of the Stone, and secures all the Vertue of that Pole to which it is applied, leading it to the other End which attracts? I take soft Iron to be so good for Armour as the choicest Steel, if not better.

XVI. That not only Steel or Iron regularly touched, but also oblong Iron void of permanent Vertue (so long as it has a transient Vertue by Position of either of its Ends towards the Pole of a Loadstone large enough to affect it at a considerable Distance) will perform all that any Loadstone can, though not with the same Degree of Power: For either of them will attract, keep one Piece of Iron suspended to another, and communicate some Degree of permanent Polarity to Steel well hardened, as I have experienced, and also to an Iron Wire.

XVII. That the Earth's central Loadstone, or Magnet, has all the same Vertues which others have, and no discovered ones besides; and though we cannot approach it, yet it acts as others do at a proportionable Distance. I have experienced, that it will keep a prepared Six-penny (or with more Difficulty a Ten-penny) Nail suspended to a prepared Iron Bar about $\frac{3}{4}$ of an Inch square, and 5 or 6 Feet long, in an erect Posture with either of its Ends downwards. I hung up the Bar in a Room
by

by a Loop of small Cord fastened at the End which was upwards ; I then carefully wiped the lower End of the Bar, and the Point of the Nail, that there might be no Dust, or Moisture, to prevent a good Contact, taking Care not to touch either of them with my Finger, lest Perspiration should sully them. Then holding the Nail under the Bar very erect, with its Point upwards, I kept it close to the Bar, by only one Finger held under the Head of it, for the Space of 30 or 40 Seconds or more. Then I withdrew my Finger very gently, and directly downwards, that the Nail might not oscillate ; and if it fell off, I wiped its Point as before, and tried it again at some other Part of the Plain at the Bottom of the Bar ; for I always found it would more readily hang at one Place than another, and usually the Middle was not so well as towards one of the Edges or Corners, and the Success better nigh one Edge or Corner than another. If both Ends of the Bar are equal in Bigness, and the Preparation of their Ends similar, it is indifferent which End is downward, if it has no permanent Vertue : But if it has no more than an inchoate or imperfect Degree of fixed Polarity, one End will answer better, and the other worse, in Proportion to the Degree of imperfect Polarity which it has.

XVIII. That of a soft Iron Bar void of fixed Polarity, so soon as it is in an erect Position, the higher Part from the Middle upward becomes a North Pole in North, or a South Pole in South magnetick Latitude. And, *e contra*, the lower Part from the Middle downward becomes a South Pole in North, and a North Pole in South Latitude : But so soon as ever the Bar is inverted, the Polarity will be shifted in it,
and

and in North Latitude the End newly placed upward becomes the North Pole, though it was a South one immediately before, and the other End the South Pole, though it was its North one just before. The Case is the same, if such a Bar is placed horizontally in or near the magnetical Meridian; for the End directed toward the North will constantly be a South Pole, and that which is directed toward the South, a North one; and so soon as ever the Ends of the Bar are shifted, the Polarity, in respect of the Bar, is shifted also (but not in respect of the Earth) for which Reason this Vertue is called Transient, and is communicated by the Earth's central Magnet in such Manner as other Loadstones are said to do, *Page 309th, Prop. 16th.*

XIX. Since in North Latitude the North Pole of the Earth's central Magnet not only gives the Vertue of a South Pole to that End of a Bar which is nearest to it, but also helps it to lift Iron when neither the Bar nor Iron lifted has any permanent Vertue; the said Magnet must therefore necessarily help the South Pole of any Loadstone or Touched Steel in lifting Iron, but hinder its North Pole. This agrees with common Experience, the North Pole of a Magnet being unable to lift so much as its South one in North Latitude, but more in South Latitude.

XX. The preceding plainly shews the Reason why an armed Magnet, when both of its Poles are applied to a Piece of Iron, will lift several times so much as with either Pole single. For the North Pole of the Magnet, by sending its Vertue through the attracted Iron, powerfully helps the South Pole of the said Magnet in attracting. Again, the strengthened South Pole

must more powerfully increase the Attraction of the North Pole : And since the Poles mutually assist one another's Attraction, with a Power much greater than if they themselves are not assisted, the conjunct Poles must necessarily lift at least twice so much as both of them can lift separately. I once tried, and found the South Pole armed to lift 1125 Grains, and both Poles united 5760 with a little more Difficulty. The Ratio is about 1 to a little more than 5.

XXI. That if a Bar of Iron or Steel (not having the least Degree of fixed Vertue) is placed in any Posture (except at, or near to a right Angle with the magnetical Line) it will not only for the present receive a transient Polarity thereby, but if it so remains long enough, the said Polarity will gradually become fixed or permanent, more or less, according to the Hardness or Softness of the Bar, Time it has remained in that Position, Angle its Length makes with the magnetical Line, and Proportion of the Length thereof to its Bigness, the longest (*cæteris partibus*) usually receiving most Vertue : And sometimes when all these Advantages concur, the Polarity will be sensibly permanent in a little Time, and not require a very long Time to be rendered pretty strong.

XXII. That by placing the said Bar afterwards in the same Position, only with its Ends shifted, it will gradually lose its gained Magnetism, and at length have its Polarity changed.

XXIII. Mr. *Boyle* found one of his Loadstones much impaired by lying long in a wrong Posture; I suppose he meant a repelling one, with its North Pole towards the North Pole of the Earth. Also by applying one Pole of a very small Piece of Loadstone to the
same

same Pole of a large one, he soon changed the Polarity of the former, but could not effect it on a Piece of any considerable Bigness, though he tried some Hours. I have changed the Polarity of a small Fruustum of Loadstone suddenly, and without a Contact, by holding one of its Poles nigh the same Pole of a Piece of Touched Steel much less than a common Case-Knife, at above $\frac{1}{2}$ of an Inch distant, which would make the Fruustum leap to it. I repeated these Changes frequently with the same Fruustum.

From this, and some of the preceding Experiments, I conclude, that if two paralleliped Loadstones equal in Magnitude and similar in Substance, Figure and Vertue, are placed close together as in *Fig. the 4th*, with the North Pole of the one directed against the same Pole of the other, or with the South Pole of the one against the South Pole of the other, and the Direction of their Polarities magnetically East and West, they will by Repulsion (as it were in a Duel) reciprocally destroy one another in an equal, though long Time: But if they are placed (in the same Situation in respect of one another, *viz.* North Pole against North Pole, or South Pole against South Pole) with the Direction of their Polarities in or near to the magnetical Line, that Stone (in North Latitude) whose South Pole stands directed to, or pretty much towards the attractive Point of the Earth's central Magnet receiving Assistance therefrom, will not lose Vertue so fast as the other, and consequently never lose all its Vertue till it has perfectly destroyed the Polarity of its Antagonist, which it will do in less Time, and afterward give it some Polarity again contrary to what it had at first.

XXIV. That Magnetism not only in touched Iron and Steel, but also in the Loadstone itself, is soon destroyed by Fire.

XXV. That though Fire destroys fixed Magnetism in Steel or Iron, yet if they are set to cool in an erect Posture, or rather in the Direction of the magnetical Line, they will gain more or less fixed Vertue by the Time they are cold; but especially Steel heated to a seasoning Height, and in that Position cooled suddenly under Water, which I have found to fix its Polarity so thoroughly, as that with its North Pole held downward, it would attract the North End of a Dial Needle.

XXVI. That while a Piece of Iron of some Magnitude is held at one Pole of a Loadstone, it will increase the Attraction of the other Pole thereof, and enable it to lift somewhat more.

XXVII. That if either Pole of a Magnet large enough, toucheth one End of an oblong Piece of Steel (not too big and long for the Magnet easily to act on) it will transmit its own Vertue to the other End of the Steel which is farthest off, and make it a Pole of its own Kind, whilst the End which touches the Stone has Vertue of the contrary Pole: But the Vertue usually is not so strong in the End which is untouched, as in that which is; though I do not know but in some Time it may gain more, and the other lose some, until the Vertue in each End is nearly equal.

XXVIII. That any Loadstone put into a Dish with its Polarity in an horizontal Situation, and the said Dish, with the Stone in it, put to swim in the Middle of a large Vessel of Water, will turn itself, with the Dish wherein it is, until its South Pole is directed in the Horizon towards the magnetical North Pole of the
central

central Magnet (by the Force of its Attraction thereof, and Repulsion of the opposite Pole) and there rest after a small Vibration or two.

XXIX. That the Fly of a Compass (because it is a perfect Magnet, *Prop. 12*) if it turns easy on its Pin, must necessarily conform its Poles to the magnetical Meridian as the Loadstone does, and for the same Reason.

XXX. Also because Steel regularly touched is a perfect Magnet, the North Ends of the Flies of several Compasses must all of them repel one another, and so must their South Ends: But the North End of one and the South End of any other, do mutually attract each other, as is said of Loadstones, *Prop. 4th*. And in North Latitude the North End of a Needle will consequently vibrate towards the Top of a transient Bar erected, and the South End towards the Bottom.

XXXI. That a Needle first equally poised, then touched and put to oscillate on its Pivots in the magnetical Meridian, will in North Latitude have its North End (*i. e.* its South Pole) depressed until it directs to the North-attracting Point of the central Magnet; where, after several Oscillations, it will at last rest: And in South Latitude the South End will be depressed after the same Manner.

XXXII. That not only a touched horizontal Needle, which has permanent Polarity, will endeavour to conform itself to the magnetical Meridian, but also one that has no other than transient Vertue, and is with the greatest Care freed from fixed Magnetism (if made and used as in the *Præcogn.*) will do so too, though with this Difference, that which End soever happens to be placed nearest towards the magnetical North will faintly

faintly turn thither ; and if that End is not suffered to remain so too long, then the other End, plac'd nearest to the North, will turn thither as the first did. In trying this Experiment, I sometimes found, that when the Needle had rested in the Meridian only a few Minutes, it gained a perceptible permanent Vertue, so that its other End would not be attracted to the magnetical North, unless it was placed considerably nearer thereto than I had placed the first End ; and having so stood some Time, lost again the said inchoate Permanency, and received Polarity, the contrary Way. Once, while I dined, and sat but a little Time after, I could not make the End which I left towards the South, to stand towards the North, unless I placed it very true in the Meridian ; so that I was forced to free it again from Magnetism before I could use it to repeat the same, or try the following Experiment ; for the least Fixedness of Polarity in the Needle would more or less obstruct both.


At the magnetical East or West of the Needle's Pin, so nice as I could guess it, I held at a great Distance, either the South Pole of a Loadstone, or lower End (which is the South Pole) of an erected Bar (both of them answered alike) and gradually approached it nearer, in a direct Line, toward the Pin, until it began to attract the Needle, which I observed was as I expected at the South End : I then changed the Ends of the Needle, and gradually approached the South Pole of a Magnet as before, and constantly found it to attract that End which was toward the South ; and the North Pole of the Magnet, after the same manner, would attract the North End of the Needle when it had only transient Vertue.

I remember, that in my younger Days I once diverted myself with making an horizontal Needle, and a Dial-Box for it, one of my School-fellows having a Load-stone. Before I could have the Use of the Stone, I often held my Needle within its Box, sometimes with its intended South End towards the Bottom of a Window Bar (having lately seen one of my Companions try it with his Pocket Needle, which was touched) and at other Times I would hold the Needle's North End at the Top of the Bar. I observed the Needle, which was hung very tender, to make Vibrations at either End of the Bar. I happened to set it down in the Window at a good Distance therefrom, and found the South End more inclined to vibrate to the Bar's Bottom than the North End, and seeing it to have some Vertue, I thought of encreasing it by taking the Needle out of the Box, and applying it to touch the Bar with its proper Ends. By this Method alone it gained such a Degree of Polarity as would constantly turn its proper End to the North, if it was kept trembling; but if I placed its contrary End to the Bar, the Polarity would be changed presently. By this Way of Management I could give it but a faint Verticity, which was soon more vigorous when I got the Use of the Stone, though it was small, and not of the best, and the Needle soft Iron. And this was all, at that Time, I knew of Magnetism, having never read the particular Properties of the Stone, nor seen one before, nor heard of the untouched Needle's Verticity, or its vibrating to a Bar.

Having within the Space of a few Years past had a fresh Inclination to make some magnetical Experiments,

riments, amongst other Thoughts the above-mentioned came into my Mind, That Iron, not having any fixed Polarity at all, might (if it moved tenderly enough) conform its Ends to the magnetical Meridian; which at length put me on making such Needles as are described in the Beginning, of which either Sort answered my Expectations abovementioned. Afterwards I touched one of the first Sort of Needles (described *Præcogn. 7th*, whose Length was $2\frac{1}{2}$ Inches, and Weight $\mathfrak{D}^{\mathfrak{s}}$ and *Gr. ij*) on a Piece of transient Iron (made for Armour of a Magnet) which measured in Inches each Side of the broad plated Part about $1\frac{1}{2}$, the parallelo-piped Part in Length 2, and in Breadth (equal to its Thickness) $\frac{3}{8}$. So its whole Length was full 3 Inches and $\frac{3}{8}$. Its Weight *Troy* was $\mathfrak{z} \text{ iij } \mathfrak{z} \text{ ij}$. This held with its Length directed in the magnetical Line, gave the said Needle Vertue enough to vibrate about four times in one Minute. I held the Needle, while touching, in an horizontal Situation, with its North End directed towards the North, and placing its Middle about the Top of the Iron, drew it along Southward: Likewise placing its Middle about the Bottom of the said Iron, I drew it Northward, that the South End might be touched as well as the North. I afterwards touched it my new Way (hereafter mentioned) with the said Piece of Armour, and a small Piece of transient Iron, which made it vibrate about six times, and I believe it would have made more Vibrations, had the Needle been hardened Steel.


Having no other than a small Loadstone of a very irregular Shape, I was loath to diminish it enough to bring it into a tolerable Figure to receive Armour, but did only grind a little Place plain at each Pole, where

where I bound it on with Thread when I had ground it. The Weight thereof naked was but 3vij 3ij Gr. vj; its armed South Pole would only lift 3vij 3s Gr. iij, which was a Key. The not knowing where to get a better, made me think of improving what I had. I considered, that since a larger Stone of the same specifick Vertue would lift more, it might possibly communicate more Vertue than mine could to the same Piece of Steel, but could not fail of so doing to a much greater Piece; and having observed that touched Steel would communicate some Vertue as well as attract, I got some Steel Wire (the largest in the Shop where I could meet with any) which having cut into equal Pieces, and filed their Ends so transversly as I could, and very plain, I made a Standard with a Plate of Iron, into which I could but just thrust the shortest; and filing all the rest till they would but just enter the said Standard, I reduced them nicely to the same Length. Then having marked one End of each of them with the Edge of a File, I seasoned them very hard, and made them, Ends and all, very bright. Each of them measured in Length about 2.74 Inches, and weighed 36 Grains or more. I weighed one of them, and they were all of the same Piece of Wire, therefore could not differ much in Weight. With my Loadstone I touched 37 of them, one by one, making their marked Ends their South Poles. I laid them Side by Side at about half an Inch Distance from one another on a Board, with their marked Ends toward the same Edge thereof, and took Care that they should not touch one another after they came from the Stone, before they were all of them touched thereon. Then having Thread and Armour made like this  (one Piece marked, which

I applied to the marked Ends of the Wires) in a readinesse, I speedily did thrust them together into a Bundle, and casting the Thread 2 or 3 times round them, with my Fingers I formed the Bundle into a regular Hexagon as soon as I could, and then bound them fast from End to End, and bound fast the Armour. I took the Number 37, because that would form a regular Hexagon at each End, and so will also 19 or 7. Finding this artificial Magnet exceed my natural one, I held the Artificial in one Hand, and the Natural in the other, the North Pole of the one against the South Pole of the other, and placing their Armour on the Middle of one of my Wires, drew the Magnets asunder, and so touched both Ends of the Wire at the same Instant. In that manner I touched one by one a second Set of Wires, which I managed like the first, and bound on the Armour of the first Set to the second. The South Pole lifted a Key, Weight *Troy* 3ij 3ij 3ij *Gr. v.* Both Poles united would, with Difficulty, lift the said Key with Weights fastened to it, the whole 16j *Troy*. I next tried with 19 Wires, for which I made Armour of a proportionable Size; but that did not answer so well, I thought, as 37, though I repeated the Touch. Afterward I took 7, which I thought performed according to its Quantity as well as the 37. Therefore I ever after used the Number 7.

In the next Place I thought of mending this Way of Touching, by placing all the 7, or more of them, with their marked Ends toward the North in a long small Trench, whose Depth was just fit for one of them, to keep it from rolling away while I was touching it and its Fellows. The North End of one touch-
ing

ing the South End of the other, and adhering by their magnetick Vertue, I placed the two Magnets, as before, at their conjunct Middle (not letting them remain there a Moment) and then instantly and speedily drew one Magnet to one End of the Wires, and the other Magnet to the other End of them ; by which Method I touched them, as it were, all at once, and as if they had been but one entire long Wire. I found this Way not only more expeditious, but more advantageous, giving all of them a stronger Touch: But the Wire at each End was not so strongly touched as the rest ; therefore I placed more Wires in the Trench than I had Occasion for, and laid aside those at each End, whose Vertue was weaker. One of these Wires, when it was thus newly touched, would lift a prepared Nail 4.75 Inches long, in Weight *Troy* 3vij Gr. vj or vij (*i. e.*) more than 426 Grains. The Weight of the Wire can be had in that of the Nail 11.8 $\frac{1}{2}$ times. I placed all the 7 separately in the magnetical Line for about two Days ; in which Time all of them had lost some Vertue, yet one of them would with Difficulty lift the Nail afore said, which it lifted somewhat easier just after the Touch ; and that which had lost most Vertue, would easily lift a Nail of 4 $\frac{1}{2}$ Inches long, in Weight 306 Grains.

Having such Success, I got seven round Bars of Steel to be made, from End to End of one Size, so that they would but just go through a Hole made on Purpose in a Plate of Iron, and tried their Lengths in a Standard as I did the others, and marked one End of each of them with the Corner of a File in this Manner,  that I might be able to see the Mark when they were bound together, lest either of them should be placed

with its End the wrong Way. Their Diameters were about $\frac{3}{8}$ of an Inch, and their Lengths about $12\frac{1}{4}$ Inches good Measure. I hardened and cleaned them as I did the Wires, but one of them happening to break by a Fall in touching, I got it supplied, and, for Fear of such another Accident, reduced them to almost a blue Colour. I laid them one after another in a Trench planed for them, in a long Piece of Wood about the Depth of half their Diameter, putting their marked Ends all one Way: I made a Hole in the Trench a few Inches from one End of the Piece of Wood, and put a Pin in it to keep the Bars from sliding to the Ground, and elevated the other End till it was, as I guessed, in the magnetical Line. I then touched them with two of my Magnets as before, and this I found the best Way of all. When they were finished, and armed with proper Armour, the North Pole lifted above half a Year after *the* *Troy*, and the South Pole considerably more. In making one of these, I met with an odd Accident; for after I had begun to touch it, apprehending it was a small Matter bigger than the rest, I attempted to mend it on a Grinding-stone, whose Axes were directed about 14 or 15 Degrees from East towards North, and from West towards South. I was not careful to keep its Poles the proper Way in grinding, but held the Bar sometimes a-cross to the Stone, which would make it jar, at other times, with the North Pole toward the North. Afterward I touched it again with the rest, but could not give it an Attraction equal to that of the others. I happened to try with my Dial-Needle whether the Change of Polarity was in the very Middle of the Bars, or nearer to one End than the other, and in this Bar found several Polarities contrary to my

Ex.

Expectation, but how many I am not certain, being several Years since, and I not heeding it nicely. As I held it erect, the Bottom was a South Pole, further up no Attraction, the Pole changing a little higher (I think one third Part of the Bar's Length) a strong North Pole, and about $\frac{2}{3}$ up a strong South Pole, and at the Top a strong North Pole, the Middle between each Pole not attracting. Whether the jarring on the Grinding-stone while held in a wrong Posture was, as I suppose, the Cause of this irregular Vertue, or whether I might at first, by Mistake, touch it the contrary Way, I durst not positively assert; but all my Care and Labour would not help it by touching: For, as the Vertue became stronger in the Ends, so did also the Polarities in the other Parts of the Bar. I was somewhat concerned at this Disappointment, doubting it must have been new seasoned, which would have created the Trouble of cleansing and polishing it the second Time. I thought first that I would try to cure it by putting it over fresh Wood-Coals in an horizontal Posture, with its intended South Pole directed towards the magnetical North, which I did, and so kept it until it was blue. Then I took it out of the Fire, and cooled it in almost the same Posture, for I think the North Pole thereof was elevated. I tried it without retouching, and found it perfectly cured, the Polarity regular throughout, and (which I was surprized at) attracted full so strongly as either of the rest.

I next endeavoured to procure Magnetism in Steel, without the Assistance of any Magnet (except the Earth's central one.)

Finding my artificial Magnets, rightly used, would communicate more Vertue to other Steel than they themselves had, and observing that erect Bars had some Vertue from the Earth's Magnet, and having also experienced that Iron, which had only transient Vertue, would, when in an erect Posture, or in the magnetical Line, give a small Degree of fixed Polarity. (*Vide supra, Pag. 317.*)

I ordered nine Steel Bars 0.75 of an Inch square, and 16 Inches long, to be made. Some of them, through the Smith's Fault, were a little less; the Weight of the heaviest was, after it was finished, 3 lb *Avoirdupois*. I made them moderately bright by grinding, and filed their Ends so plain as I could, and transverse to their Lengths, by help of a Carpenter's Square; then marked one End of them, and, when hardened, I scowred them bright, and polished their Ends very well. I fitted a Piece of Armour for each End of one Bar, and marked the Piece which was for the marked End of the Bar, and bound fast both Pieces of Armour to the same Bar, one at each End: Then standing with my Face toward the West, and holding the Palm of my Left Hand upward, I placed therein one of the Bars without Armour with its marked End Northward, and grasped it fast at its Middle, with my Fingers on the West Side, and the Ball of my Thumb on the East Side, where I also laid along my whole Thumb to keep it steady: So the upper Part of the Bar was open from End to End. Thus holding it, I elevated the South End thereof until I guessed it was in the magnetical Line; and holding with my Right Hand the armed Bar, with the Poles of the Armour downward, and the marked End toward the North depressed to the magnetical

magnetical Line, I placed the Pole of the upper Armour about 4 or 5 Inches from the Top of the unarmed Bar, and so soon as ever it touched the Bar, I began, with the greatest Speed I could make, to draw it downward until I was past the Middle, and from thence to the Bottom gradually slower. When it was at the Bottom I permitted it to rest there about 1 or 2 Seconds. After the same Manner applying the Pole of the lower Armour to the unarmed Bar about 4 or 5 Inches from its Bottom, I drew it upward, speedily at first, slower when above the Middle, letting it rest a little at the Top. Having upwards and downwards alternately repeated the Touch on the same Side of the Bar, I touched the opposite Side thereof, which was next my Hand, in the same Manner, and afterwards the two other Sides. Then holding the unarmed Bar erect, I used to see if it had gained any fixed Polarity by holding my small Needle at the Top and at the Bottom of the Bar; for if it had gained any Vertue by the Touch, it would attract the Needle stronger, at the same Distance, when the marked End of the Bar was held downward, than when it was held upward. If I found it had gained any sensible Vertue, I took off the Armour from the first Bar, and bound it to the second which I had touched, and after the same Manner touched the first Bar with the second, as I had touched the second with the first. And when by Trial with the Compass Needle I found the armed Bar had communicated to the other more Vertue than was in itself, I took off the Armour and bound it to that which was newly touched, and therewith retouched that which I had disarmed. In a few Repetitions of changing the Armour from Bar

to Bar, and touching the weakest, I procured in both of them (without the Assistance of either of the other seven) a fixed Polarity to such a Degree as that the North Pole, or unmarked End of either of them held downward, would attract the North End of the Needle, though much fainter than if the North Pole of the Bar had been upward, and Position did not now change their Polarities, but only weaken them: Therefore I now call their Vertue perfectly permanent. Four or five Repetitions more encreased their Vertue to such a Degree as that the South Pole of one of them would lift a Ten-penny Nail prepared, and after 2 or 3 Repetitions more a common Door Key of an Iron Box-Lock, Weight *Troy* 3j and above 3ij, not by the Bow, but by its lower End, which was wrought somewhat globular and polished. In the last Place I got a Piece of Inch Deal above three Inches broad and 7 or 8 Feet long, in the Middle whereof, at about 5 or 6 Inches from one End, I made a Hole through with a large Gimlet, into which I drove an Iron or Steel Pin, whose Length (besides what went into the Wood) was a little less than the Thickness of one of the Bars. Then I placed the biggest Bar on the said Board with its marked End close to the Pin, and its Length parallel to that of the Board, and with an Awl made four small Holes in the Board, one of them on each Side of the Bar about an Inch from the Bottom, and about the Thickness of a Sixpence, from its Sides, and the other two after the same Manner, about an Inch from the Top. I drove into them Pins of large Wire half an Inch long, besides what was in the Board. The Pins were to keep the Bars from sliding out of their Places in touching. Then removing that, and placing
any

any other Bar between the said Pins, with its marked End close against the great Pin, I placed the marked End of the said biggest Bar close against the unmarked End of the other, and made four Holes on its Sides, and drove Pins in them as before, and so continued to do, until the Board was full : It held half a Dozen Bars. I took Care to place the marked End of every Bar directed towards the great Iron Pin which was to keep them from sliding down to the Ground, when the other End of the Board was elevated, to stand in the magnetical Line. The Board standing with one End on the Ground, and the other leaning against the Wall, at the South End of the Room, I took the armed Bar, which had Vertue, and placed its North Pole's Armour about the Middle of the highest Bar, whose Middle I could reach to (keeping the Armour of the South Pole a little upon one Side of the Bars, just so far as I might be sure not to touch them with that End) and then immediately drew it from thence downward to the Bottom of the lowest Bar : After the same Manner placing the Armour of the South Pole on the Middle of the lowest Bar (and holding the armed North Pole on one Side, that it might not touch) I drew it upward to the Top of the highest Bar, whose Top I could reach. And if the End of any Bar was a little under that which it rested against, I used to put a sizeable Chip under it, that the Armour might not hitch in drawing it over the Places of their Contacts. I usually touched the Bars on all four of their Sides, then took out the lowest, and (letting the rest gently slide down to the Iron Pin) placed it at the Top, that those which were first at the Top might in their Turns take their Places in the Middle, and be well touched.

I commonly rested at the End of each Bar in drawing (as in the single Bar before mentioned, *Pag.* 325.) When I found those on the Board considerably stronger than my armed one, I took out that which I thought attracted best, and bound the Armour to it, putting the other in its Room. After several repeated Touchings, the biggest of them being *liij Avoirdupois*,



would be suspended by its North Pole to the South Pole of one of the best of the others. They did not lift one another, or attract so well when their Ends were applied centrally, as when applied to one another (as is expressed in the Figure) near to their opposite Corners. The Line *m* in the End of each Bar represents the Manner I used to mark their intended South Poles. With one of these armed, I touched a small square Bar of Steel (placed betwixt two of the great ones) the Length whereof was 2.156 Inches, the Breadth of each Side 0.27 (or somewhat more than $\frac{1}{4}$ of an Inch) the Weight 3v *Gr.*iv (*i. e.* 304 Grains) it would

lift afterwards an Iron $5\frac{1}{2}$ Inches long, weighing 3iv 3j 3j or, 2000 *Gr.* 304 can be had 6.578 times in 2000. So it lifted above $6\frac{1}{2}$ times its own Weight. With this little Bar naked I touched a small Dial-Needle made of Steel (the Socket in the Middle was also Steel, and not Brass, as usual) I seasoned it very hard, and cleansed it well, and with much Care, not to break it, because so hard. It weighs not full 4 Grains, has lifted two prepared Six-penny Nails, one at each End, while it was held in an horizontal Posture with its South Pole towards the North. It also lifted a Key by the Bow, as it was held perpendicularly

dicularly with its South Pole downward, the Weight whereof was 3j 3ij Gr. xv good Weight (*i. e.* 115 Grains or better) Wherefore since the Needle weighed less than 4 Gr. which is the 29th Part of 116, we may reckon it lifted full 29 times its own Weight by the Force of one Pole, the Key having no permanent Vertue before.

I never saw this Communication of Magnetism outdone by the Loadstone itself, as it is commonly used; but what a good one would do, used as I did the Steel, I know not for want thereof, but doubt, unless Steel could be made better than it usually is, a stronger Degree of Attraction therein is scarce to be hoped for from the Use of the best of Loadstones.

I usually find the attractive Power in square Bars cut plain over transverse to their Lengths, to be strongest, not in the Middle of their Ends, but much nearer to their Corners or Sides, and to be greater at one Corner or Side than another; and this not only in such as are of touched Steel, but in Iron ones having no Polarity, but from their Position. The same I observed in round Bars, if their Ends are not convex.

In some of my large Steel Bars (as also in some of the round Bars) I found the North Pole strongest, in others the South. I know not the Cause thereof; for though I touched the weaker End twice so often as the stronger, it would still continue to be so, when the strongest had been well touched before. I imagine it must be owing to some Inequality of the Steel occasioned by the different Degree of Heat taken at the Forging; different Degree of Heat when the Smith desisted hammering; different Degree of Heat in making the Iron into Steel, or Quantity of what is used in doing it; Fineness of

the Iron whereof the Steel was made, some small Difference in Magnitude, or Difference in seasoning, it being almost impossible to make both Ends equally hard; but that both Ends of mine might be so, I had a Fire made long enough to heat their whole Length at one and the same Time.

I left several of the Bars on the Board whereon they were touched, and in the same Position to one another, as well as to the Earth, for some Months, to see whether they would lose any of their Vertue; but if they did, it was so little as I could not be sure thereof.

I also tried whether what I mentioned concerning Loadstones (*beginning at Page 303*) would hold in 5 or 6 Bars regularly touched and placed to one another in the same Manner; and found that at some of the Joinings it answered pretty well, but not so well at others, usually best at the two extreame Joints, and worse at the middle ones. When I held the Dial-Needle at a good Distance from the Bars (perhaps 6 or 8 Inches) the Attraction was more regular, and the different Poles of the two Bars at their Contact was not so easily discernable; but when I held it within 2 or 3. Inches Distance, both of the Poles discovered themselves more or less at every Joint. Perhaps the Cause may be the Want of a better Contact, the Ends of the Bars not being true Plains; or it may be partly owing to their conjunct Length (though I cannot see how that should cause it) or some Irregularity in the Vertue of each particular Bar. For it has been observed, that very oblong Iron, as Wire, is capable of having a North Pole in both Ends, and a South one in its Middle; or, as my round Bar before-
menti-

mentioned, several Polarities in no greater Length than about one Foot. My Bars were not made of *German*, but more ordinary Steel, of about 4*d.* per lb.

I never yet tried the Experiment of weighing Pieces of oblong Steel just before, and presently after the Touch, but suppose (from Mr. *Norman's* Experiment, *New Attractive*, Chap. vi.) that my own Conjectures are right, *viz.* That oblong Steel of a convenient Length and Weight, perhaps 3 or 4 Feet, and 10 or 11 Ounces, may, if weighed with a very nice Beam, made of Iron or Steel, the Cords of the Scales being of a common Length, seem to lose a Grain or two of its Weight (more or less according to the Substance of the Beam, Shortness of the Cords, and Degree of Magnetism in the touched Steel). I say, seem to lose, because the touched Steel with one of its Poles attracts the Beam not just at the End thereof to which it is suspended, but there, and, more or less, all the Way between the said Point of Suspension and the Middle of the Beam. This must make it apparently (not really) to ponderate less, as is the Case of Stilliards, demonstrated by the Doctrine of the Lever: Also the other half of the Beam being somewhat attracted by the other Pole of the Steel, assists the Weights which are laid against the Steel, and encreaseth the Mistake, which is greater or less, according to the Posture of the Steel, whether (if horizontal) it is parallel or perpendicular to the Beam, or (if in an erect Posture) according to which Pole is upward. My Thoughts are, that Steel after the Touch (Allowance being made for what is rubbed off by touching, which I take to be insensible, if done on soft Armour) must, if in an horizontal Posture, necessarily
draw

draw somewhat more Weight than before ; or if in an erect Posture in North Latitude with the South Pole downward more, and upwards less than in an horizontal Posture : But these Differences are so small as no Experiment I can think on will render sensible in the least Degree, because of the vast Distance between the Surface of the Earth and the attractive Point of the internal Magnet : For since Attraction and Repulsion are at the same Distance equal, I say the one Pole of a Bar of Steel 10 or 20 Feet long, directed toward the attractive Point of the Magnet, supposed at the Distance of but one or two Miles, is not sensibly nearer to it than the other (I mean in respect to Attraction) how much more insensible then must the far greater Distance of 2000 Miles render it, which is not so remote as Mr. *Whiston* (Longitude and Latitude found by the Dipping-Needle, *Pag.* 48. *Line* 12) supposes it to be. I cannot think fit to call the Point to which the Needle tends a respective Point, as Mr. *Norman* does, since his Experiments, *Chap.* VI. do not convince me (by reason of the Distance thereof from the Surface of the Earth) that it is not an attractive one. If therefore Steel after the Touch is ever found to weigh (with a Beam of Matter not magnetic, and in a Place at too great Distance from any Iron or Magnet to be sensibly affected thereby) either more or less than before, it must be occasioned by the Augmentation or Diminution of its Quantity of Matter by the Touch. The former seems impossible, because a Magnet loses no sensible Weight by having 10000 Pieces of Steel successively touched on its Armour ; nor is the latter probable, unless the Weight of the Magnet is encreased, or Part of the Substance
of

of the Steel ground off by touching : And if the Quantity of Steel is, by rubbing, diminished, the Lightness is not owing to its having Magnetism, but to its Defect of Matter. Before an Experiment of this Nature is made, the Piece of Steel should be well hardned, polished, and wiped very clean, and if warm by rubbing or handling, should be permitted to cool before it is weighed. Then being weighed with a Brass Beam, let it afterward be well touched on the soft Armour of a Magnet, then wiped clean, and permitted to cool, before it is weighed after the Touch. Care must also be taken that no Iron Bar, or other Magnet, be in the Window, or any other Part of the Room above, or that underneath, large enough to affect it, which a Magnet, the Brads of the Floor, or other Iron in the same Room, or about the Operator, such as a Key, Knife, Buckles, or the like, may more or less do, according to their Distance and Situation : And I have seen a Brad in the Floor make the End of a large horizontal Needle dip to it at the Distance of above an Inch.

Mr. *Whiston* in his said Book, *Pag.* 47, supposes the Surface of the Earth's central Magnet to be distant in Miles from the Surface of the Earth 3400, and accordingly, *Pag.* 48, computes the Semidiameter of the said Magnet to be about 575 ; both which Sums added, make the Semidiameter of the Earth to be about 3975 Miles ; which is about 7 Miles less than Mr *Norwood* makes it by reckoning $69\frac{1}{2}$ Miles to a Degree, which multiplied by 360, makes 25020 in the whole Circumference, and the Radius (by *Van Ceulen's* Proportion of the Circumference to the Diameter) I find to be 3982.0566, &c. which 7 Miles is but a Trifle in 3975, or 3982.

I shall

I shall then suppose the Earth's Radius (in Miles) 3975, from whence I compute the Circumference 24975.6615,9603,8855, &c. And one Degree 69.3768,3776,6774,5988,3, &c.

Mr. *Whiston*, *Pag.* 53, says that the Northern magnetick Pole was then about $13\frac{1}{2}$ Degrees from the North Pole of the Earth: The Sine of which in natural Numbers is 233,4454 to the Radius 1000,0000.

1. As the Earth's Radius (in Miles) 3975, to the above-mentioned Sine of $13\frac{1}{2}$ Deg. 30 Min. 233,4454. So the said Magnet's Radius 575 Miles to the Tabular Number 33,7688,3144,6540 8805,0311, &c.

2. As the Tabular Radius 1000,0000, to the said Tabular Number, so (in Miles) is the Earth's Radius to the Radius of the Parallel of $13\frac{1}{2}$ Gr. on the said Magnet's Surface: Or, so is the Earth's whole Circumference to the Circumference of the Central Magnet's said Parallel: Or, so is one Degree of the Earth's great Circle in Miles to one Degree of the said Parallel of $13\frac{1}{2}$ Gr. on the said Magnet's Surface 2.3427,7474,0840,2028,43, &c.

The said Degree reduced into Feet, and into Inches, is,

In Feet and Parts 12369,8506,3163,6271,0156,59, &c.

In Inches and Parts 148438.2075,7963,5252,1879,14, &c. Which 2.3427, &c. Miles the North magnetick Pole of the central Loadstone moves in somewhat less Time than 4 solar Minutes, *viz.* in about 4 Minutes by the diurnal apparent Motion of the fixed Stars) But for as much as the *Ratio* of the internal Magnet's Diameter to that of the Earth, is not probably calculated to Perfection, I shall proceed as if the said Pole of the Magnet moved the said Space perfectly in the Time of four Stellar Minutes. For

For want of a more convenient Instrument, I took a Whirligig of Wood, somewhat more than $\frac{1}{4}$ of an Inch thick, and in Diameter at least 1.8 Inch. It was turned truly round, and had in its Diameter nigh to, and equidistant from the Centre two Holes made, into which, as usual, was a Thread put, of about 40 Inches long, and about 20 when it was put in, and the two Ends tied together. I went with it to a Clock, whose Pendulum oscillated Seconds, and working the Whirligig strong enough to make its Returns, or Vibrations, keep equal Times with the Pendulum's Oscillations, I suddenly caught the Whirligig at the End of one Vibration before it began another, and then (untwisting the double Thread gradually with my Fingers) I told how many Turns or Revolves it had made in that one Vibration, and found the Thread untwisted with 58 Turns (which is but half the Number in one Vibration, because in the whole Vibration it was twisted the like Number of Turns the other Way) which doubled makes 116 Turns in each Vibration, and in one Second of Time. I computed the mean Velocity of the Circumference thereof in each Second of Time to be about 54 Feet 7 Inches 9645,4606, &c. Parts. By this it is plain, that a Globe (as well as a Wheel) of 6 Inches in Circumference, if truly centered, is easily capable of being kept in Motion on its Poles, so swift that its Æquator shall have the Velocity of 51 Feet 5410,44298, &c. Parts, by making 103.0820.8859, &c. Turns in one Second. This is the proper Velocity for such an Experiment, because it is nearly equal to that of the North magnetick Pole of the internal Loadstone along the Parallel of $13\frac{1}{2}$ Degrees from the Poles of its Rotation.

The Velocity of the said magnetical Pole of the internal Loadstone is, as above, in the Time of 4 Minutes, in Inches and Decimal Parts 148438.2075,7963,5252,1879,14.

And therefore in the Time of one Minute 37109.5518,9490,8813,0469,786, and in one Second 618.4925,3158,1813,5507,8297, which 618.4925, &c. Inches reduced to Feet and Decimal Parts, is 51.5410,4429,8, &c.

Suppose then a Terrella was made of just 6 Inches in Circumference $N \approx S n$ (*Vid. Fig. 1. Pl.*) contrived to gyrate on Poles $\approx n$ chosen in any two opposite Points of its magnetical *A*equator, and the Axis of its Rotation $\approx n$ situated (as near as Art can do it) in the magnetical Line; for in this Posture of the Axis the magnetical Poles of the Terrella will be equally wrought on by the Earth's attractive Point all the Way as it is turned round, which can be in no other Posture whatsoever: For if the Axis of its Rotation makes the least Angle with the magnetical Line, as the Terrella is turned round, the magnetick Poles of it will be attracted and repelled more when on one Side than when on the other, which ought not to be, because it is probable it may have the same Effect which a large Magnet would have, if held within the Attraction, and consequently change the Polarity, as by a Touch, and not purely by the Gyration thereof.

The Circle $N \approx S n$ represents the Terrella in Circumference just 6 Inches (having both, or at least one, of its attractive Poles nicely marked) cemented, or bound with Thread fast to a cylindrical Vessel of Wood, or Brass pretty thin, that it may not be too heavy, with its Polarity $N S$ transverse to the Axis of the said

said cylindrical Vessel, whose Diameter on the Inside ought to be equal to that of the Terrella, and its Depth not less than the Radius. Or, if the Terrella is truly globular, instead of the cylindrical there may be a concave Vessel (represented by the pricked Line $\propto n w$) less than a Hemisphere, and its Diameter of Concavity somewhat less than that of the Terrella ; so shall their Contact be wholly at the Brim of the Vessel, which will keep the Terrella central. And this may be better than a Cylinder, because lighter, and the most of its Parts nearer to the Axis of its Verticity. Either of these is to be centrally fixed to the Arbor $n m$, which, together with its Pivot r , should be made of Brass, and the Pivot Work in a Hole made fit for it in a Horse's Tooth, or some such Thing : The End of the Pivot should rest on the Bottom of the Hole, that it may move the easier. The Collar at P, in which the Arbor turns round, may be made of Tooth also, and both that and the Pivot aforesaid should be kept well oiled, or greased, to prevent their being heated by so rapid a Motion as is necessary, and so should also the other Axles. This is to be kept in Motion by a Gut-string (as the Spill of a Spinning-Turn is moved) tied pretty strait round the little Wheel at m , and the greater one at F, which String is represented by the pricked Line. And the Wheel F is turned after the same Manner, by a larger Gut-string round the Wheels t and Q, which must be strained very straight, that it may not slide on the Wheels. To prevent which Inconvenience, this String (and the other, if need be) may be rubbed well with powdered Rosin. I think a Gut-string round a great Wheel and lesser one, will work easier than the best of Clock-work, and without rattling

or jarring, which the latter, when in a rapid Motion, is subject to, and therefore I cannot approve of it, nor is the multiplying Power of the Wheels $\propto F$, being 10.3082, &c. so nearly to be calculated for a Wheel and Pinion; but, if good Work, it may be allowed in the Wheels $\propto Q$, which move slower: But that I apprehend will needlessly encrease the Charge. The Diameter of each Wheel at the Bottom of the Trench, where the String touches it, is mentioned in the Draught. The whole may be made to turn with one's Hand, either with a Crank Qg in the Arbour of the Wheel Q , or with a Turner like that of a Grinding-stone R .

Mr. *W*———*n*, Page 78, makes one Revolution of the central Magnet, in respect of the Earth, to be not less than 1920 Years, which I have reduced to 701280 Days, to which I add 1920 Days, which makes the Sum 703200, being the Number of Revolutions, nearly, which the Earth and the said Magnet with it, makes in 1920 Years in respect of the fixed Stars. Now since the magnetick Pole of a Terrella 6 Inches in Circumference, centered as above is directed, and moving with the Velocity of 51 Feet 5410.4429, &c. Parts in the Time of one Second, by making 103.9820,8839, &c. Turns, moves equally rapid with that of the central Magnet, it may be expected that 703200 of its Revolutions, should gradually translate each of its Poles one entire Circle, which 703200 Revolutions (at 103.0820, &c. *per* Second) will be finished in the Time of 6821 Seconds 7476,9272,396 Parts, or $1^h 53' 41'' 44''' 51'''' 41'''''$. Or,

351600 Revolut. translate it $\frac{1}{2}$ a Circle in 3410.8738, 4636,198^u, or 0.56' 50'' 52''' 25'''' 50'''''.

175800 Revolut. translate it $\frac{1}{4}$ of a Circle in 1705.4319,
2318,099", or 0.28' 25" 26''' 12'''' 55'''''.

117200 Revolut. translate it $\frac{1}{5}$ of a Circle in 1136.95795
4878,732", or 0.18' 56" 57''' 28'''' 36'''''.

If the Terrella's Circumference is more than 6 Inches, the magnetical Poles thereof may be placed so oblique to the Axis of the Cylinder, as that in turning round they may each of them describe a lesser Circle (or as it may be called a Parallel of Latitude) just 6 Inches in Circumference, and that will cause no Alteration in the Swiftneſs of the Motion of the Machine, which is to be moved as follows, *viz.* The Perſon that works it muſt keep his Eye on a Pendulum oſcillating Seconds, and turn the Crank (or Turner) once round at each Oſcillation, ſo ſhall the Number of the Terrella's Revolutions, and Celerity of the Motion of its Poles be as is above-mentioned.

But if the Terrella is larger than 6 Inches in Circumference, and its Polarity tranſverſe to the Axis of its Rotation, the Pendulum may be lengthened in Proportion of the Squares of their Circumferences, and the Crank muſt then make one Turn at each Oſcillation of the Pendulum ſo lengthened; and by that Means it will move with the ſame Celerity, which was above propoſed; but then the 703200 Revolutions will not be finiſhed in leſs Time than 6821 Seconds (or rather Oſcillations) made by the lengthened Pendulum.

If by the keeping a Terrella in Motion in ſuch a Poſture, and with ſuch Celerity as is aforeſaid, the magnetical Poles thereof, in reſpect of the Terrella, remain immoveable, I think this is a plain Demonſtration that the central Magnet is looſe from the Earth,

Earth, and revolves within it a little slower, as is conjectured by several, and to me seems most probable.

But if the magnetical Poles, by such a Motion as is described, should in respect of the Terrella be translated with a Motion retrograde to that wherein it was kept by the Machine, I should think it possible for the diurnal Motion of the central Magnet to translate the Polarity thereof farther Westward by the Vertue of its own Effluvia, which are continually left a little behind, as it revolves on its Axle Eastward, and that the said Magnet is fixed to the Earth. But these Things seem uncertain.

However, I think it not impossible to reduce the Period of the Motion of the magnetical Pole, in respect of the Earth, to a tolerable Calculation in much less Time than an entire Revolution thereof, by measuring daily the Quantity thereof: For effecting which, I have thought on a new Way of making a Needle not above 6 Feet long, with some Engine-work to its Box, which, I believe, I can demonstrate will render it visible daily to a naked Eye, that the Variation is changed: But I have no Time at present to describe it, being but just able to finish this; but if it may be acceptable, shall readily communicate it on Notice.

- II. *An Essay upon the Use of the Bile in the Animal Oeconomy, founded on an Observation of a Wound in the Gall-Bladder.* By Alexander Stuart, M. D. Physician to her Majesty, and F. R. S.

The CASE of Mr. Menzies, Sergeant in the Second Troop of Horse-Grenadier Guards, wounded in the Gall-Bladder, with the Appearances in the Body after Death, and the Symptoms during Life; with some practical Inferences drawn from it.

H E was wounded about Three o'Clock in the Morning, the 30th of *October*, 1728, and died the 5th of *November* following in the Morning, being the seventh Day after he was wounded, in the fortieth Year of his Age.

Appearances in the Body, opened by Mr. *Coldham*, Surgeon, in the Presence of Messieurs *Fiquel* and *Black*, Surgeons, with several Gentlemen, and myself.

I. The *Abdomen* appeared distended as in a Tympany, or *Ascites*, and the Skin of the Belly tinged yellow as *Saffron* in many Places.

II. A triangular Wound appeared about two Inches on the right Side of the Navel, the Direction slanting upwards obliquely through the Integuments.

III. The Belly being opened, discovered the Wound to have penetrated through the *Peritonæum*, and the Sword had slanted upwards from thence along the *Omentum*, grazing slightly upon it, which was superficially ruffled, but so as to be hardly perceivable.

IV. A

IV. A small triangular Wound appeared in the Bottom of the *Gall-Bladder*, which had penetrated through the Membranes into its Cavity, but had nowhere wounded the Liver, nor any of the neighbouring Parts.

V. The *Gall-Bladder* was flaccid or collapsed, containing only a few Drops of Gall, which, by pressing the *Cystis* slightly, flowed out into the Cavity of the *Abdomen* through the Wound.

VI. The *Guts* throughout their whole Tract being distended, so as could be judged to triple the Extent of their natural Diameters, seemed to fill the whole Cavity of the *Abdomen*, so as to give the outward Appearance of a Tympany, or Ascites; which Distension disappeared, and the *Guts* collapsed, upon making several Punctures with a Lancet in their Sides, to give Vent to the Air.

VII. The rest of the Cavity of the *Abdomen*, which was not closely filled up by the distended Guts, contained a gross muddy Water, or Serum, intensely yellow, or highly tinged with Gall, to the Quantity of three Quarts, as I was able to guess without measuring it.

VIII. All the *Guts* and Contents of the *Abdomen* were highly tinged with this yellow Liquor, but no other Part of his Body, out of the Contact of this Liquor, had the least Appearance of it.

IX. No Inflammation appeared in any Part of the *Guts*, or in any of the *Viscera*, or Contents of the *Abdomen*, which were all found and healthy.

X. The Obliquity of the Wound through the *Integuments*, *Muscles* and *Peritonæum*, made it impossible

fible for the external Air to enter into the Cavity of the *Abdomen* that Way.

The Symptoms during Life.

I was called the 2d Day of *November* about Eleven o'Clock in the Forenoon, being the fourth Day after he received the Wound.

I. The Surgeons who had attended him from the Beginning, Messieurs *Fiquel, Coldham, Wilkie* and *Black*, being present, told me that his Belly had been distended, as I saw it, from the Beginning, giving the Appearance of a Tympany, or Ascites, and it continued at the same Pitch of Distension, neither diminished, nor sensibly encreased, to the Time of his Death.

II. No *Ructus* or *Flatus*, upwards or downwards, nor *Borborygmi*, notwithstanding this Distension of the Belly.

III. He never went once to Stool after he received the Wound, though pretty strong Purgatives and several Clysters had been given for the three Days before I came ; and though no Opiat (which might have been supposed to have retarded their Operation) had hitherto been exhibited : Neither had those Purgatives nor Clysters, which I ordered afterwards, the least Effect.

IV. He took what was thought a sufficient Quantity of Drink and liquid Food.

V. He never slept, or but very little, by short Slumbers, of about half an Hour, or an Hour at longest, and that very rarely, notwithstanding pretty large Doses of Opiats were given to procure Rest, after I came.

VI. The Wound in the *Integuments* never digested in the usual Manner; but looked flaccid, or flabby and pale, almost without Pus.

VII. The *Urine* in very small Quantity, at most two or three Spoonfuls at a time, clear but yellow, as if tinged slightly with Saffron, and without Sediment.

VIII. His *Pulse* was full, strong and even, but not quick.

IX. No feverish Heat to be felt in the *Skin*, on any Part of the Body.

X. His *Tongue* not hard, rough or black, as in a Fever, but of its natural Colour, with a silky Driness, and very little *Saliva*.

XI. He was not in the least delirious, from the Beginning to the Time of his Death.

XII. He had some slight Fits of the Hickup the second Day after I saw him, and some few Reachings to vomit; some Intermissions in his *Pulse*, sometimes one in 10, 15, 20, or 30 a Day before his Death.

In order to make some Use of this Case, it is necessary to premise, that as Reasoning without a Foundation in Facts and Experiments, does rarely lead to any Certainty in Natural Knowledge, so Observations of Facts and Experiments themselves, would be, in a great Measure, fruitless, if we did not endeavour, by Reasoning, to draw obvious, useful and practical Conclusions from them: In order to which, it must be observed, That the great *Apparatus* in the *Liver* and *Spleen*, two of the largest *Viscera* in the Body, confessedly designed for the Preparation and Secretion of the *Bile*; and the Place of the *Intestines*, into which it is immediately deposited, afford indeed a strong Argument

gument for the universal Use of it in the Animal Œconomy ; but do not directly point out what, or how many these Uses are, about which there has been a great Variety of Opinions.

But this singular Case, which must have happened very rarely, if ever before (wherein none of the Inwards, or *Viscera*, but the *Gall-Bladder* only was wounded, and by that Wound nothing but the *Gall* was lost or misplaced) by shewing how many Functions in the Animal Œconomy were impaired or destroyed by the sole Loss or Want of it, does at the same Time point out or demonstrate the Use and Necessity of it towards Health, or the Perfection of these Functions ; and perhaps may lead to some Indications of Cure, in Cases wherein it is known to be deficient, faulty or redundant.

There was no other apparent or assignable Cause for these various Symptoms during his Life, of Death itself, and of those several Appearances in the Body dissected after Death, but this Wound in the *Gall-Bladder* : And as this Wound could not affect any of the Parts, nor produce these Symptoms in any other Sense than as it gave Vent to the *Gall* into the Cavity of the *Abdomen*, and deprived the Cavity of the *Intestines* and the *Blood* of it : Therefore from this Loss and Misplacing of the *Gall*, all these Symptoms and Appearances may justly be concluded to arise, and I think may be accounted for from that Cause in the following Manner.

I. The *Abdomen* was distended, as in a Tympany, or Acites, from the Beginning, and the *Guts* appeared inflated to their utmost Diameters.

It is true, that this Inflation and Distension happens to most a few Hours before Death, and to all soon

after Death, and ariseth from the Spring, or Elater of the Air included, getting the better of its Antagonist Spring, or Elater of the muscular Fibres of the *Stomach* and *Guts*, which have no longer the Assistance of the *Blood* and *Spirits* to contract them, and keep up their peristaltic Motion. But the Inflation and Distension here spoken of, was several Days before Death, and, as I have been told, the very next Day after he received the Wound, though the *Pulse* was apparently strong and equal, and therefore a Defect of *Blood* and *Spirits* not to be suspected: And therefore it may be justly concluded, that the Influx of the *Gall* into the Cavity of the *Guts*, is as necessary to the Strength of their Contraction and Perfection of their peristaltic Motion, as that of the *Blood* and *Spirits* into their *Sides*; and that these three are the conjunct Causes of this Motion in Health, which would be defective by the total Want of any of them.

Hence we see that in Scyrrhosities of the *Liver*, where the Secretion, and therefore the Excretion of the *Bile* is more or less defective; and in the *Jaundice*, where, by some Obstruction in the *Biliary Ducts* after Secretion, a Part of it is forced back, and regurgitates into the *Blood*, and very little of it is thrown into the *Guts*: I say, in those Cases we observe an uncommon Distension in the *Guts*, and Costiveness; which, if the Case proves incurable, terminates in an *Acites*, or *Dropfy*, in the Cavity of the Belly.

It may also be worth while to enquire, whether that which is commonly called an *Hysteric*, or nervous *Cholic*, generally attended with a lesser Degree of such like Distensions, with *Flatus's* and *Borborygmi*; I say, whether this Distemper, wherein the animal

mal Spirits are so much, and only accused, does not partly arise from a sluggish Secretion and Excretion of the *Bile*, occasioning a Defect in its Quantity; or from its Acrimony and great Viscosity, occasioned by its Stagnation in the *Gall-Bladder*; or from both these, as well as from a defective or unequal Distribution of the *Blood* and *Spirits* in the Parts affected. In confirmation of which, I have generally observed, that at some time or other in the Cure, a great Evacuation of porraceous viscid *Bile*, brought away either by Art or Nature, as well as a great Profusion of pale *Urine*, finished the Cure for that Time. The Vomiting of porraceous *Bile*, very common in such Cases, proves the same; and, I believe, it is generally allowed, that the ferruginous, porraceous and black Colour of the *Bile*, are owing to shorter or longer Stagnations of it, chiefly in the *Gall-Bladder*, which the sedentary Life of those who are subject to these Cholics, will sufficiently account for, even if there was no other Error in their Way of living; and whoever has observed the high yellow Colour and Contents of the *Urine* in a *Jaundice*, arising from a Redundancy of *Bile* in the *Blood*, will readily acknowledge that an uncommon watery Paleness in the *Urine*, where no more than the usual Quantity of Fluids has been taken down to dilute it, does shew a Defect of *Bile* in the *Blood*; and I believe it is easy to account for the *Flatus's*, *Borborygmi*, Inversions of the peristaltic Motion, the *Pila Hystrica*, *Palpitations*, *Scotomia*, *Vertigo*, and other Symptoms of these Distempers, which are called Nervous and Hysterical, from the same Cause. And hence it is, that Bitters and Steel, known *Deobstruents* of the *Liver*, and *Correctors* of the *Bile*, with gentle Chologogues

in very small Doses, are of so much Use in such Cases ; though it be certainly true, that all strong stimulating Purgatives are very hurtful and improper.

II. But to return to our Case, there was no *Ructus's* or *Flatus's* upwards or downwards, nor *Borborygmi*, notwithstanding this Distension of the *Belly* and Inflation of the *Guts*.

This, I think, shews very plainly that the *Guts* had lost all Motion, and were Paralytic by a total Want of *Bile* only, as much as if their Nerves had been totally obstructed : For had any Motion remained in them, whether the natural and regular peristaltic Motion, or a preternatural convulsive one, the Contraction of them either Way, would have propelled the contained Air from one Place to another, and would have occasioned *Borborygmi*, or would have expelled a Part of it upwards or downwards, when Nature had so much need of it to relieve the distended *Guts*, and Art had contributed to that Intention by Clysters and Purgatives given.

Which serves to illustrate what has been said above, concerning the defective and convulsive Motion of the *Guts* in Hysterick Cases, where, through a Defect in the Quantity or Quality of the *Bile*, or from both these, the Motion of the *Guts* becomes defective, irregular or convulsive, but is not totally lost through a total Want of it, as in this Case.

III. He never went to Stool after he received the Wound; and the strongest Purgatives and Clysters that could be reasonably given, had no Effect.

This seems also to be owing to the Want or total Loss of the peristaltic Motion; and plainly shews, that the strongest purging *Stimulus* has not the Power
to

to restore it, without the Assistance of the *Gall*: For had it been in any Degree restored, the *Belly* would have fallen proportionally, and some Evacuation of what was lodged in the *Primæ Viæ* would have followed.

If then the Power of Purgatives depends upon the Co-operation of the *Bile*, it will follow, that where it is most active or redundant, their Operation will be, *cæteris paribus*, greatest; and where it is unactive or deficient in Quantity, they will have proportionally a less Effect. Though it be true that a great Quantity, or morbid Acrimony of the *Bile*, by a too strong and violent Irritation, will bring the *Intestines* into such Spasms, as to stop all Excretion by Stool; and the strongest purging *Stimulus* added to it does only encrease the Spasms and Costiveness; as in *Bilious Cholics*, which are always attended with exceeding Costiveness, not conquerable by the strongest Purgatives, if they be not joined with Opiats, to allay the Spasms, and obtund the Acrimony of the *Bile*.

He took what was thought a sufficient Quantity of liquid Food and Drink; but if the Elater of the *Guts*, and their peristaltic Motion were lost, it is easy to prove that none of his Food or Drink could enter the *Lacteals* for want of the peristaltic Motion; and therefore that he died starved. And this will account for all the rest of the Symptoms mentioned.

To prove that this was his Case. All that have seen live Dissections, intended to shew the Nature of the peristaltic Motion, and the Course of the *Lacteals*, must have observed, that the *Guts* have an alternate *Systole* and *Diastole*, or Contraction and Dilatation called the peristaltic Motion, the superior Section

con-

contracting itself, while the immediate inferior is dilated ; and this Motion is carried on in several Parts of the *Guts* at the same time ; and the contracting Part, by expelling the *Blood* and *Chyle* out of its Sides, in its Contraction looks pale, while the Parts dilated look florid, and the Vessels full of *Blood* and *Chyle*.

Now the Part contracting must necessarily force the *Chyle* from the grosser Parts of the Food or Aliments, towards the inner Surface of the *Guts*, where the perforated capillary Extremities of the *Lacteals* in the villous Coat are ready to admit, or rather to absorb it by Attraction, as far as the larger and visible Branches of the *Lacteals* on the Coats of the *Guts*, into which it easily flows in the Time of Dilatation, or Diastole, which expands and unfolds these Vessels at that Time for its easy Reception ; from which it is farther propelled by the next Systole, or Contraction, into the primary or first Order of the *Lacteals* in the *Mesentery* ; and by the same repeated Impulses of the contracting Sections of the *Guts*, is forced farther through the second Order of *Lacteals* in the *Mesentery*, into the *Receptaculum Commune*, and the *Thoracic Duct* ; assisted by Valves, and promoted by the incessant Motion of the *Muscles*, and of all the Contents of the *Abdomen* and *Thorax* in Respiration, it is at last poured into the *subclavian Vein*, for a perpetual Recruit of the *Blood* in a healthy State.

But if the first Movers in this Series fail, that is, if the muscular Fibres of the *Guts* have lost their peristaltic Motion, as in this Case, then the Expression, Absorption and Progress of the *Chyle* described, cannot succeed, the *Blood* must be deprived of its Recruit, and the Person die starved ; which, as I have said

said before, seems to have been this Person's Case, and will sufficiently account for the rest of the Symptoms above recited.

First, His Want of Sleep, and the Inability of *Opi-um* to procure it, might be owing to a Want of Recruit of *Chyle* in the *Blood*: As we see that those who live sparingly, sleep very little, and those who feed plentifully, require by so much a greater Number of Hours to sleep; and in all chronical Cases, where the Body ceaseth to be nourished, the Sleep also fails, and Opiats have but little Power; whereas in Children, where a great Part of their Food goes towards both Nourishment and Accretion, the greater Part of their Time is spent in Sleep.

It may indeed seem difficult to conceive how a Want of Rest should ensue so soon after the Accident. But considering that the Loss of one Meal in a Day, especially of Supper, to such as have been accustomed to sup, has occasioned fewer Hours Rest in the following Night, it will follow, that such Persons require at least some small Recruit once in six or seven Hours, in order to rest their usual Number of Hours; and therefore in our Case, where all Recruit must have ceased soon after the Accident, he might be sensible of the Impairment of Rest in six or seven Hours after it, and those about him might well observe the Encrease of that Symptom, at least in the following Night.

Another Difficulty ariseth from the Observation of *Swallows* and *Tortoises*, &c. who sleep most in Winter, when they eat and drink nothing. In answer to which, there seems to be no Parity between the natural Constitution of their Blood and Humours, and that of Men: To these, and such like Animals, with

regard to Recruit and Nourishment, Action and Rest, the Spring and Summer are as one Day, and the Winter as one Night; and their Blood and Humours seem to be fitted by God and Nature, not only to bear, but even to require such long Periods of Rest and Action. And probably there is as little Parity between the Crasis and Constitution of the Blood and Humours of a healthy Person, and of those in soporous and cataleptick Diseases, who are reported to have slept for Weeks or Months without Food of any kind: And therefore, I say, where the Crasis and Consistence of the *Blood* and *Spirits* are nearly the same, that is, *cæteris paribus*, he who feeds, and is nourished most, will sleep longest, & *e contra*.

The Position here advanced is farther confirmed by the Inefficacy of the Opiats given, they being capable of entering into the *Blood* through the Pores of the *Stomach* in Contact with them; by which quick Passage they have been observed to procure Rest soon after they have been applied outwardly, or taken down into the *Stomach*, as in this Case they may justly be supposed to have done: Though, for the Reasons above-mentioned, neither they nor any thing else could pass by the *Lacteals*: But as the Aliments could not pass that Way, *viz.* by the Pores of the *Stomach*, nor by the *Lacteals* into the *Blood*, there could be no Recruit nor Nourishment: And therefore the Opiats, though they did enter into the *Blood* by the Pores of the *Stomach* in Contact with them, could not procure Rest. Thus it would seem probable, that Opiats do produce their Effect by detaining the *Chyle* crude longer than usual in the Mass of *Blood*, and thereby lengthening Sleep beyond the usual Time;
and

and that they are ineffectual where there is no *Chyle* in the *Blood* to be detained.

But to explain how *Opiats* do contribute to retain the *Chyle* and other Crudities in the *Blood*, longer than usual, would require a Disquisition too tedious for this Place : But their Power of retarding or suppressing all or most of the Secretions and Excretions ; their palling or obtunding the Appetite ; their enabling one to fast long, and supporting one in Journies and Labour for a long Time without Food (Effects well known to the *Turks* and *Asiatics* in their Journies through Deserts, &c.) these, I say, and some other known Effects of *Opium*, do very much favour this Opinion.

Secondly, The Want of *Pus* in the Wound was probably owing to a Want of Recruit of *Chyle* in the *Blood* ; and the Flabbiness and Paleness of its *Lips*, to a Shrinking of the Parts for want of daily Nourishment.

Thirdly, The small Quantity of *Urine* was probably also owing to a Want of Recruit of *Fluids* from the *Primæ Viæ* : For these, in a healthy State, find their Way to the *Urinary Passages* very soon. The slight Tincture of Yellow, which it had, must have been from the *Bile* spilt in the *Abdomen*, and filtrated through the Duplication of the *Peritonæum*, and Bottom of the *Bladder* : For it could not be supposed to derive its Colour from the *Blood*, into which no *Bile* could now enter by the common Way.

Fourthly, The Want of *Saliva*, and the silky Dryness of the *Tongue*, seems to have been owing to the same Cause, a Want of Recruit of *Fluids* in the *Blood*, and a Loss of so much of them as fell into the *Abdomen*.

Fifthly, If it be supposed that such a small Wound through the *Integuments* and *Muscles* of the *Abdomen* and the *Peritonæum*, was capable of producing a *Fever*, then ~~his~~ not having any Symptoms of a *Fever*, must be owing to a total Defect of *Bile* and *Chyle* in the *Blood*, none of which could enter the *Lacteals* for want of the peristaltic Motion, as has been said.

Lastly, The few Fits of Hickup, Reachings to vomit, and Intermissions in the *Pulse* in declining and dying Persons, seem to arise not only from a Defect, and therefore an unequal Distribution of the *Blood* and *Spirits*, but chiefly from the Corruption and irritating Acrimony of them, as the immediate Cause of Death in this and most other Cases. Which will be farther explained in the following Pages.

OBJECTION I.

It may very reasonably be objected here, that the *Ductus Hepaticus* would carry a Sufficiency of *Bile*, for the Uses of the Animal OEconomy, into the Cavity of the *Intestines*, though none came by the *Ductus Cysticus*; and Nature seems to have provided the *Ductus Hepaticus* for this Purpose, that if any Obstruction or Defect should happen in any of these Secretory Channels, the Secretion and Excretion might go on for the Benefit of the OEconomy, in the other: As Nature has provided two Kidneys, and double Organs of Sense, for the same Reason. But the Effect will not be the same in a Wound, which is the Reverse of an Obstruction; because by a perpetual Evacuation through it, such a Revulsion and Derivation is made, as drains and deficcates all the neighbouring Parts, and either lessens

or

or entirely frustrates the Secretion and Excretion by them : And this we find to be true, where the Secretory Organs and Ducts concerned in the different Secretions, lie at a great Distance from one another ; as in the *Diabetes* we generally see a very great Desiccation of the *Salival Glands*, a Defect of *Saliva*, and a perpetual Thirst ; and Sweating and Looseness lessen the Secretion by *Urine* ; an *Issue* drains and emaciates the neighbouring Parts ; and it is mechanically demonstrated by *Bellini*, that the Flux of the *Blood*, and of all the Humours, will be most and strongest towards the Part where the Resistance is taken off ; as in Bleeding, to which this perpetual Flux of *Bile*, through the wounded *Gall-Bladder*, seems to have a great Affinity ; and therefore would probably promote the Afflux of *Blood* and Secretion of the *Bile* so much and so strongly towards the *Vessels*, *Glands*, and *Secretory Ducts* leading to the *Cystis*, as very much to lessen, or totally to hinder the Secretion by the *Ductus Hepaticus* into the *Guts* by that Channel : And therefore, in this Case, the whole of this useful Juice seems for this Reason to have been totally lost to the Animal OEconomy.

OBJECTION II.

Another Objection is, that as the *Guts* and other Contents, and even the *Muscles* and *Integuments* of the lower *Belly*, were highly tinged by the *Bile*, it is probable that some of it has got into the Cavity of the *Guts*, where it might, by its *Stimulus*, keep up the peristaltic Motion, and by the *Lacteals* get into the *Blood*, for the Use of the Animal OEconomy ; as
it

it appears that some of it got into the *Bladder* in that Manner, and tinged the *Urine*.

It is not unlike that this might happen when the *Bile* came to be very redundant in the Cavity; but in passing through the Interstices of the *Vessels* and *Fibres* of the *Guts*, as through a *Filtre*, the grosser, saline and sulphurous Particles of it, which are the most pungent and active Parts, must have been left behind; which the muddy Thickness, as well as Deepness of the Colour of the Liquor found in the Cavity of the *Abdomen*, compared with the transparent Clearness of the *Urine* of a much lighter yellow Colour, without Sediment, does seem to prove: And it is not likely that such a small Quantity of filtrated *Bile*, as may be supposed to have passed that Way, deprived of all its active Particles, could either in Quantity or Quality be sufficient to assist in any Function of the Animal OEconomy, whether Natural, Vital or Animal: And, in Fact, if any passed that Way, it appeared plainly insufficient to promote the Contraction and peristaltic Motion of the *Guts*, which remained preternaturally distended, as has been said, from the Beginning to the Time of his Death.

OBJECTION III.

It has been also objected, that an Animal which dies starved, dies delirious and feverish, the Experiment having been made on Cats and Dogs: And therefore this Person, who had no Fever, nor Delirium of any kind, cannot be supposed to have died starved.

I will not dispute these Facts, especially the Experiments upon Cats and Dogs, though I have not made any myself, nor do I remember to have had any just
or

or accurate Account of the Symptoms of such who have died of Hunger and Thirst, in Sieges, and at Sea ; though many Instances have been, and no Notice, that I know of, has been taken of their having died mad, delirious or feverish, though these Symptoms are so remarkable and affecting. But supposing these Facts, these Cases will differ very much from this before us: For an Animal starved to Death purely for Want of Food, has the *Gall* flowing continually into the Cavity of the *Intestines*, unmixed and undiluted with *Chyle*, and from thence by the *Lacteals* into the *Blood* ; so that in a few Days this acrimonious Juice must become more redundant there, than any other Humour ; which joined with the constant Attrition of the Globules in Circulation, must soon render the *Blood* very acrimonious, rancid and alcalin ; that is, must reduce the whole to a Mass of Putrefaction, capable of stimulating the *Brain* and *Nerves*, so as to produce a Fever, Delirium or Madness : But in the Case under Consideration, no *Gall* could enter into the *Blood* : And therefore this Degree of Putrefaction, and the Effects of it, could not happen ; though it must be owned, that, through a Want of Recruit and Dilution, a lower Degree of Putrefaction of the *Blood* and *Humours* must have followed, even in this Case, from the continual Attrition in Circulation ; such at least as was sufficient to render the whole Mass in a few Days unfit for any of the Uses in the Animal Economy, or the Functions of Life : And therefore may be justly supposed to have been the immediate Cause of Death : For all the passive Principles or Materials of Putrefaction, being actually in the Substance of the *Blood*, and all the active Principles

ples of Heat and Attrition being at work upon it to produce this Effect, it could not fail to be brought about in a few Days; and the same would happen to all Animals, is what is effete, corrupted or altered, so as to be unfit for the Use of the Animal, was not continually carried off by the *Emunctories*, and a fresh Recruit daily supplied from the *Primæ Viæ*; which Evacuations and Supply being kept up in their due Quantity and Proportion, do effectually prevent all Putrefaction and Acrimony, and keep the Blood and Humours in their natural Temperature, commonly (though mistakenly) called Sweetness.

It is not then a Defect in the Quantity of *Fluids* which kills an Animal in Fasting, but a poisonous Acrimony, which the *Blood* and *Humours* naturally contract, for want of a fresh Recruit and equal Evacuation. Thus in chronical Distempers, where the Person appears extenuated and exhausted, the Quantity of the *Fluids* is certainly very small, yet enough to maintain Life for some Months or Years, being kept in some Degree of Sweetness or proper Temperature, by a certain Proportion of Recruit and Evacuation: But where the Recruit is entirely substracted, the Evacuations will be proportionally lessened: And therefore the Quantity of *Fluids* may remain much the same, but the Quality will alter, and Putrefaction for the Reasons above assigned must take Place, and be the immediate Cause of Death, even long before the Mass of *Fluids* can be much diminished in Quantity, as in the Case before us. Which leads to the Answer of another Difficulty, *viz.*

OBJECTION IV.

How the *Pulse* should continue full, strong and equal for several Days, while the Person was in a starving Condition, and the *Blood* had no Recruit from the *Primæ Viæ*?

This indeed would be very unaccountable, if the Waste of the *Blood* and *Humours* were supposed to continue at the same Height as before the Accident, and the Evacuations by the *Emunctories* were the same as in perfect Health. In this manner the Contents of the *Blood-Vessels* would be soon wasted and exhausted: But *Sanctorius's* Observations and Experiments do shew, that the daily Recruits and Evacuations keep Pace with one another, and are nearly equal in 24 Hours in a healthy State: And therefore where the Recruits are plentiful, the Evacuations will be equally so; and where those are sparing the Evacuations are small; or where the Balance is cast too much of either Side, some Indisposition or Distemper must follow. There is no Exception from this Rule, but in Children, a Part of whose Nourishment goes to Accretion, and the Encrease of their Weight: Therefore in the Case before us, the Recruit being entirely subtracted, the Evacuations must have been little, or next to nothing: And therefore the Quantity of the *Blood* and circulating *Humours* would remain much the same, and keep up the Fulness, Strength and Equality of the *Pulse* for several Days, until the *critical Putrefaction* and *Colliquation* of the *Blood* above-mentioned, on the fifth or sixth Day, rendered it unfit for a regular Circulation; and produced Intermissions in the *Pulse*, Reachings to Vomit, and Hickup, all of them being local Convulsions, and

the Effects of Corruption, Acrimony, Irritation, and an unequal Distribution of the *Fluids*, which terminated in Death in the Beginning of the seventh Day.

The Sum of what has been said is, that in this Case very little, if any, *Bile* entered into the *Intestines*, and that ineffectual; and none at all into the *Blood*. And as there was no apparent Defect in any Part of the Body, nor any Wound that could have been either dangerous or deadly, in any other respect than as it gave Occasion to the Loss and Misplacing of the *Gall*; it is therefore evident, that all the Symptoms, and his Death, were entirely owing to the Loss of this useful Juice; which it seems is so necessary to all Parts of the Animal OEconomy, Natural, Vital and Animal, that this Person could not live above six Days without it.

The practical Inferēnces that seem to flow by necessary Consequences from this Observation, are,

I. That the peristaltic Motion of the *Intestines* is as much owing to the Influx of the *Bile* into their *Cavity*, as to the Influx of the Animal *Spirits* and *Blood* into their *Sides*: And therefore that the *Bile* is to be looked upon as one of the prime Movers in the animal OEconomy, by which the elastic Springs of the natural Motions, to wit, the *muscular Fibres* of the *Guts* are set to work; upon whose Motion all the subsequent vital and animal Motions do so far depend, that none of them can be long in Perfection where it is imperfect, nor subsist many Days where it is totally wanting.

II. This prime Motion is totally lost by a total Want of *Bile*; proves sluggish by a Defect in its Quantity; becomes irregular or convulsive by a great Redundancy

dundancy or morbid Acrimony of it. From whence several Distempers that are called *Nervous* may arise, and are more likely to be cured by correcting and evacuating the redundant or faulty *Bile*, and disobstructing the *Liver*, than by most other Medicines taken from the common Class of *Nervines*.

III. That the Power of Purgatives depends upon the Co-operation of the *Bile*: And therefore it is probable, that the Difference of Constitutions, at equal Ages, with respect to Purgatives, depends more upon the Quantity and Quality of the *Bile*, than on the Bulk or Weight of the *Body*, Quantity of the *Blood*, or other *circulating Humours*.

IV. It also appears that the Nourishment and Accretion of the Body do in some Measure depend upon a due Quantity and proper Quality of this Juice, without which the *Blood* and circulating *Humours* could not be recruited from the *Primæ Viæ*: And therefore that Defects in it may be frequently the Cause of a *Marasmus*, or Waste of the Body, where it is little suspected: Which may serve to point out the Method of Cure in such Cases.

V. This Observation seems to lead to the Knowledge of the immediate Cause of natural Rest or Sleep in a healthy State; to wit, a certain Quantity or Proportion of fresh *Chyle* in the *Blood*; the Want of which, from whatever Cause, will occasion Watchfulness, or some Degree of it. And this may serve to point out the immediate Effect and Consequences of *Opiats*, whence may be gathered how far, and in what Cases they may be effectual and useful; and in what Circumstances they may be ineffectual, useless or hurtful. Which may deserve a farther Illustration.

VI. That a due Quantity of *Aliments*, at proper Intervals of Time, is necessary to keep the *Blood* and *Humours* in their natural Temperature and Sweetness, and to preserve them from Acrimony and Putrefaction: And this will be true in all Distempers as well as in Health, and is against the Practice of such as pretend to starve away Distempers, or to deny a due Quantity of Drink and liquid Food to the Sick, especially in Fevers, where the Want of this Recruit will tend to encrease the Acrimony or Putrefaction, whence the Malignity of most Fevers does arise.

VII. That *Pus*, or Matter in a Wound or Ulcer is the Product of *Chyle*, and not of the *Blood* or *Serum*: Which has indeed been the received Opinion, though supported by no other Proof than the Similitude of *Pus* to *Chyle*. And as a great Redundancy, as well as a Defect of *Pus*, does sometimes retard the Cure of a Wound or Ulcer, this may serve to shew by what Means it may be encreased or diminished, to answer the Intentions of the Artist.

This also makes it appear probable, that a great Redundancy of *Chyle* disposeth the Body to purulent, suppuratory and scrophulous Distempers; and seems to indicate the subtracting such Sorts of Food as afford a rich, gross or plentiful *Chyle*, and the administering of such Medicines as may strengthen Sanguification, and the other assimilating Powers, to assimilate and thereby consume it; the Sanguification and assimilating Powers being manifestly weak, as the Chylification seems to be strong in all such Cases. And this seems to be the Reason why in *Adults*, as the Sanguification grows stronger, and in *Age*, as the Voraciousness of the *Appetite*, too common in Youth,

Youth, declines, these Distempers do often decrease, and at last wear out of themselves: Which shews what Assistances Art ought to contribute, to bring about the same Effect in a less Time.

I must here own my Omission to open the *Stomach* and *Guts*, in order to view the State of their Contents, where the *Gall* was entirely wanting, which might have given some Light to this Observation. This Omission happened through some Hurry at the Time, which I regret; but am apt to believe, that as most of his *Aliments* were Liquids, the Alterations would not have been very conspicuous or obvious to the Sight. And I hope it will not be impracticable to make some Experiments on live *Animals* for this Purpose, with more Care and Attention, for supplying what may have been defective in this Observation.

III. *Observatio Lunaris Eclipsæ, Ulissipone habita die 2 Februarii, An. 1730, N. S. in Collegio Divi Antonii magni à Rev. P. Joanne Baptistæ Carbone, Soc. Jes. Ex ejusdem Cl. Viri Epistola ad Jacobum de Castro Sarmento, M. D. Coll. Med. Lond. Lic. & R. S. S.*

Temp. Ver. P. M.

H. ' "

- | | | | |
|----|----|---|------------------------------|
| 13 | 25 | o | Incipit penumbra sensibilis. |
| | 40 | o | Fit spissior. |
| | 58 | o | Fit spississima. |

Dubi-

Temp. Ver. P. M.

H.	'	"	
14	3	45	Dubitatur de Eclipsis initio.
	4	32	Nunc certo incipere videtur.
	6	0	Jam discus Lunæ apparet deficiens.
	9	47	Umbra attingit plagam Borealem Ter- ræ Pruinæ.
10	25		Pervenit ad Harpalum.
11	6		Medium Harpali tenet.
16	15		Attingit Litus Boreale Sinus Iridum.
18	34		Heraclides totus tegitur.
22	38		Plato incipit.
23	50		Medius Plato latet.
24	54		Totus Plato obumbratur.
29	40		Umbra ad Aristarchum.
31	55		Ad medium Aristarchi.
33	42		Totum Aristarchum occultit.
34	55		Aristoteles obumbrari incipit.
36	24		Medius Aristoteles tegitur.
37	49		Aristoteles totus in umbra.
39	9		Eudoxus totus.
43	57		Umbra attingit Endymionem, & Ari- stillum simul.
44	53		Medius Endymion, & totus Aristillus latet.
45	48		Endymion totus.
48	27		Timocharis totus ; umbra pervenit ad Litus maris Serenitatis.
	55	50	Ad Lacum Somniorum.
	56	30	Aristarchus incipit emergere.
	58	20	Medius Aristarchus extra umbram.
15	0	34	Aristarchus totus emergit.
	4	25	Possidonius incipit obumbrari.

Lacus

Temp. Ver. P. M.

H.	'	"	
15	11	35	Lacus Somniorum totus, & dimidium Possidonii occultatur.
	13	12	Timocharis incipit emergere.
	16	5	Timocharis emergit totus; & totus Possidonius occultatur.
	27	54	Archimedes totus extra umbram.
	30	49	Possidonius incipit emergere.
	32	58	Heraclides totus.
	34	3	Possidonius totus.
	40	46	Harpalus totus.
	46	21	Platonis initium.
	47	16	Platonis medium.
	48	33	Plato totus extra umbram.
	50	55	Lacus mortis totus.
	52	37	Aristoteles incipit emergere.
	54	29	Aristoteles medius extra umbram.
	56	58	Aristoteles totus.
16	1	48	Endymionis initium.
	3	14	Endymion totus.
	4	0	Finis Eclipsis.
			Duratio Eclipsis 4 H. 59' 28"
			Medium Eclipsis 15 H. 4' 16"
			Quantitas Digit. 3 Min. 20. ad Boream.

IV. *Observationes Cœlestes Multifariae inter Menses*
Novemb. 1727, & Novemb. 1728,
Pekini in SINIS, habitæ & ad Rev.
P. Joannem Baptistam Carbone, Soc. Jes.
transmissæ. Ex eadem Epistola descriptæ.

I. *Immerfiones, & Emerfiones Satellitum Jovis*
observatæ Pekini in Sinis.

SATELL. I.

		D.	H.	'	"	
Immerfiones.	{	Nov. 2	10	21	10	Vesp.
		10	0	14	26	Mane.
		11	6	44	10	Vesp.
	{	Dec. 3	2	30	42	Mane.
Emerfiones.	{	10	4	22	5	Mane.
		11	10	50	0	Vesp.
		13	5	17	50	Vesp.
		19	0	40	44	Mane.
		20	7	8	20	Vesp.
		26	2	32	33	Mane.
		27	9	0	0	Vesp.

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		D.	H.	'	"	
1728.	Emerfiones.	<i>Jan.</i>	3	10	51	50 Vesp.
			5	5	20	0 Vesp.
			11	0	45	18 Mane.
			12	7	13	27 Vesp.
			19	9	5	40 Vesp.
			26	10	59	0 Vesp.
			28	5	27	20 Vesp.
		<i>Feb.</i>	4	7	22	0 Vesp.
			11	9	16	40 Vesp.
			18	11	12	30 Vesp.
	Immerfiones.		20	5	41	50 Vesp.
		<i>Mart.</i>	21	7	58	55 Vesp.
		<i>Sept.</i>	20	1	12	12 Mane.
		<i>Oct.</i>	4	5	6	0 Mane.
			13	1	30	0 Mane.
			20	3	26	15 Mane.
			27	5	19	30 Mane.

S A T E L L. II.

Immerf. 1727.	<i>Nov.</i>	6	4	5	40	Mane.
Emerfiones.	<i>Dec.</i>	1	3	40	45	Mane.
		4	5	2	0	Vesp.
		11	7	37	42	Vesp.
		18	10	11	13	Vesp.
		26	0	47	39	Mane.
1728.	<i>Jan.</i>	5	4	42	0	Vesp.
Emerfiones.		12	7	16	16	Vesp.
		19	9	51	0	Vesp.
	<i>Feb.</i>	13	7	3	45	Vesp.
		20	9	46	0	Vesp.
Immerfio.	<i>Oct.</i>	30	3	34	10	Mane.

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S A T E L L

S A T E L L. III.

1727.	D.	H.	'	"	
Incipit	{ Nov. 21	7	57	0	Vesp.
emergere		28	11	53	Vesp.
1728.					
Immerf. tot.	Jan. 3	5	43	40	Vesp.
Emerf. prima		7	42	0	Vesp.
Immerf. tot.	10	9	42	52	Vesp.
Emerf. prima		11	42	20	Vesp.
Immerfio	{ Feb. 22	9	42	30	Vesp.
totalis.		2 Oct. 9	6	6	30 Mane.

II. *Observatio Eclipsis Lunæ die 19 Aug. 1728, habita Pekini in Observatorio publico.**Horol. Corr.*

H.	'	"	
			Non multo ante Eclipsim dimensa diameter Lunæ erat 30' 50".
10	54	0	Penumbra jam inficiebat partes Lunæ primo inumbrandas.
11	2	0	Initium Eclipsis paulo infra Cleostratum.
13		0	Umbra attingit Aristarchum.
14	30		Obtexit totum.
15	20		Attingit Platonem.
16	50		Obtexit totum.
22	20		Attingit Galilæum & Timocharim.
23	20		Pitheam.
26	30		Kepplerum.
27	30		Aristillum.
31	30		Hevelium, Copernicum, & Endymionem fere simul.
36	20		Ricciolum.
38	15		Posidonium.
40	10		Grimaldum, & Mercurium.
41	40		Manilium.

Mene.

H.	'	"	
II	43	40	Menelaum.
	47	0	Plinium, & Geminum.
	52	0	Umbra ad centrum Lunæ, obteſto Grimaldo toto.
	54	20	Attingit mare Cri-
	56	40	Ariadæum [ſium } Grimaldi apice au-
	57	0	Proclum } ſtrali hærente ad
			} marginem umbræ.
12	0	0	Culminante Luna recta per medium Ty-
			chonem tendens inter Munofium, &
			Profatium ad Copernicum coincidit
			cum plano Meridiani.
	2	30	Umbra attingit Promontorium } Lente
			acutum, admo-
	4	30	Cenforinum & Tarantium, dum e-
	6	0	Mare Crifium totum obteſtum, mergen-
	15	30	Umbra attingit S. Theophilum, te Gri-
	16	0	S. Cyrillum, } maldo.
	21	30	Langrenium. Grimaldo integre emerſo.
	25	15	S. Catharinam, Ricciolo toto reſeſto.
	31	0	Circa medium Eclipſis micrometro di-
			menſa quantitas obſcurationis erat
			Sinice digit. $6\frac{1}{2}$ ferme, ſive more Eu-
			ropæo digit. $7\frac{1}{4}$.
12	34	0	Emerſit Hevelius totus.
	36	0	Umbra ad Fracaſtorium.
	43	0	Galilæus
	46	30	Lansbergius } integre deſeſti.
	52	0	Keplerus }
13	1	0	Ariſtarchus }
	2	0	Copernicus incipit emergere.
	5	0	Totus deſegitur.
	10	0	Margo umbræ per centrum Lunæ.
	11	30	Pitheas emerſit.
	15	0	Eratoſthenes & S. Cyrillus deſeſti.

H.	'	"	
13	20	0	Timocharis & S. Theophilus detecti.
	22	20	Ariadæus }
	25	0	Manilius
	29	30	Aristillus integrè emerferunt.
	32	0	Plato
	33	0	Cenforinus }
	34	0	Promontorium acutum.
	38	0	Plinius, & Langrenius integrè detecti.
14	0	0	Finis Eclipsis proximè Berofum.

In fine Eclipsis diameter Lunæ inventa est 30' 38".

Durante Eclipsi sæpius addensati vapores turbabant faciem Lunæ, ut ejus maculæ, & umbræ margo non satis distinctè possent discerni; maxime id accidit ante, & circa finem Eclipsis.

III. Aliquot Occultationes fixarum per Lunam, observatæ Pekini, A. C. 1728.

Januar. die 2 Mane Luna occultavit Stellam ϵ *Leonis* Immerfio. erat 2^h 35' 20" in recta per Tychonem & S. Theophilum Emerfio fuit 3^h 20' 40" in recta per S. Theophilum & Eratosthenem.

Die 22 Summo Mane Luna transivit per *Pleiadas*. 1^h 0' 25" immerfit *Taygeta* post Lunam, in recta cum Bullialdo, & Abilfedea.

1^h 9' 30" *Celæno*, à Cuspide cornu australi pauculis secundis distans in recta ex Tychone per Clavium, mox disparuit nimia fluctuatione lucidi limbi Lunæ absorpta.

1^h 18' 24" immerfit *Sterope* in recta cum Bullialdo, & Fracastore.

1^h 25' 56" *Maia* in recta ex Tychone per Longomontanum. Emerfio nullius videri poterat ob nimiam fluctuationem lucis Lunæ inter vapores.

Die 29 Vesp. Luna obtexit Stellam τ *Leonis* Immerfio

sio fuit $9^h 27' 53''$ in recta cum Galilæo, & Lansbergio. Emerfio verò $10^h 24' 17''$ in recta cum Macrobio & Sofigene.

Mart. die 21 Vesp. occultavit Luna Stellam γ *Canceri*. Immerfio fuit $8^h 14'$ in recta per Copernicum & Boreum marginem Langreni. Emerfio fuit neglecta.

Maii die 24 Summo Mane $1^h 51' 30''$ Luna abforbuit Stellam τ *Scorpionis* proxime Byrgium. Emerfio non fuit observata.

Sept. die 14 Vesp. Luna occultavit Stellam η *Capricorni*. Immerfio fuit $8^h 11' 20''$ inter Seleucum & Cardanum. Emerfio $9^h 37' 30''$ paulo infra Langrenum.

Die 19 Vesp. Luna obtexit Stellam δ *Piscium*. Immerfio fuit $8^h 43' 45''$ in recta per Tychonem & Langrenum. Emerfio autem $9^h 5' 15''$ in recta cum Tychone & Keplero.

Oct. die 28 Manè Luna occultavit Regulum, seu Cor *Leonis* Immerfio fuit $1^h 39' 50''$ in recta per Aristarchum & Gassendum. Emerfio $2^h 11' 15''$ in recta per Aristarchum & Cardanum.

V. *An Account of the Veins and Arteries of Leaves.*
By Frank Nicholls, M. D. *Præf. Anat. Oxon.*
F. R. S.

BY a Letter from Dr. Fuller in *Holland* to the President, and communicated about *October* last, the Society was informed, that the ingenious Professor *Ruyfch* had observed something in the dissecting of Leaves analogous to the Veins and Arteries of Animals; but without explaining in what Manner these different Vessels were disposed, or by what Means they may be distinguished from each other.

When

When I had the Pleasure of examining the Collections of *Frederick Ruysch* and *Albert Seba* at *Amsterdam*, in both which were great Variety of dissected Leaves, they made no Mention of such Discovery; although in a Leaf from the Collection of *Ruysch* I could (with a Glass) observe the Fibres to be double towards the Edges of the Leaf; which at that Time I imagined to be an unnatural Division of the Fibres, as in decayed Sticks.

In the mean Time, *Albert Seba* having communicated the Method of dissecting Leaves to the Society, by a Letter to the President, I separated the pulposus from the fibrous Parts of several Leaves after his Method; when examining them by Glasses, and in Water, I found that each Fibre was naturally separated into two distinct Fibres by a thin *Stratum* of the pulposus Substance; and that this Separation was continued through all the Fibres and Stem of the Leaf, so as to form two distinct Planes of similar Net-work.

Though this Duplication of the Vessels in Leaves seems to point out an Analogy between them and the Veins and Arteries of Animals, yet I see no probable Means of guessing which are the arterial and which the venal Fibres.

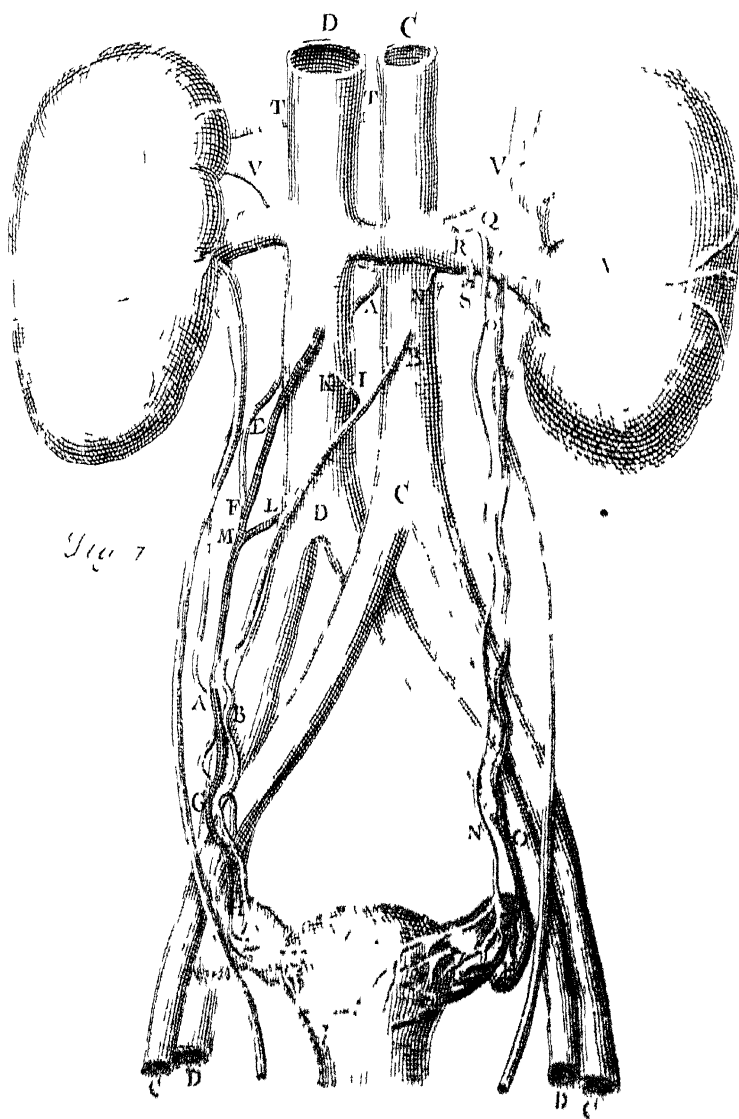
That I might illustrate this Matter, as it appeared to me, I have prepared two Leaves, the one of an Apple, the other of a Cherry; in which, as well the Separation of the Fibres and Stem, as the pulposus Substance, by which they are naturally separated, are very obvious. See Plate II. A the Cherry-Leaf; B the Apple-Leaf, whose Planes are separated.

Both which (the Society having nothing of this Nature in their Repository) I desire may be accepted as a Mark of the Respect of their

Most Humble Associate,

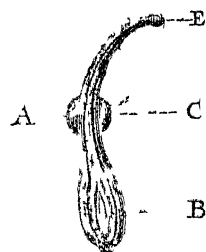
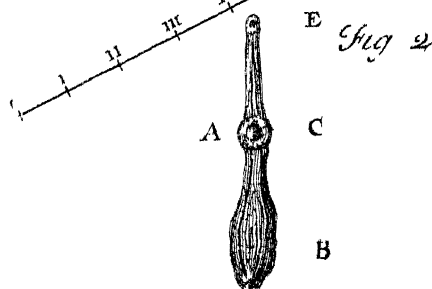
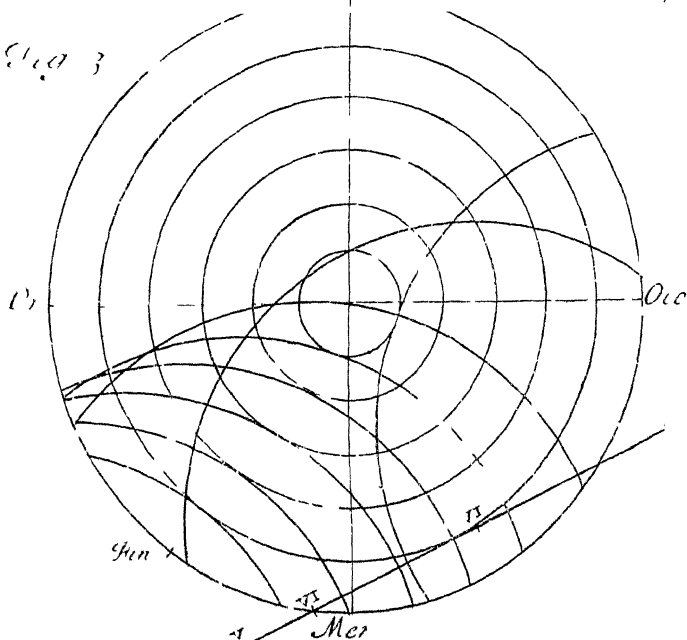
June 11, 1730.

F. NICHOLLS.



Sup. Phlebus N^o 445

Fig 3



Oxyoides Malabarica sensiviva
 Caule viridi glabro altiore, flore majore



Fig. 2.

Fig. 3.



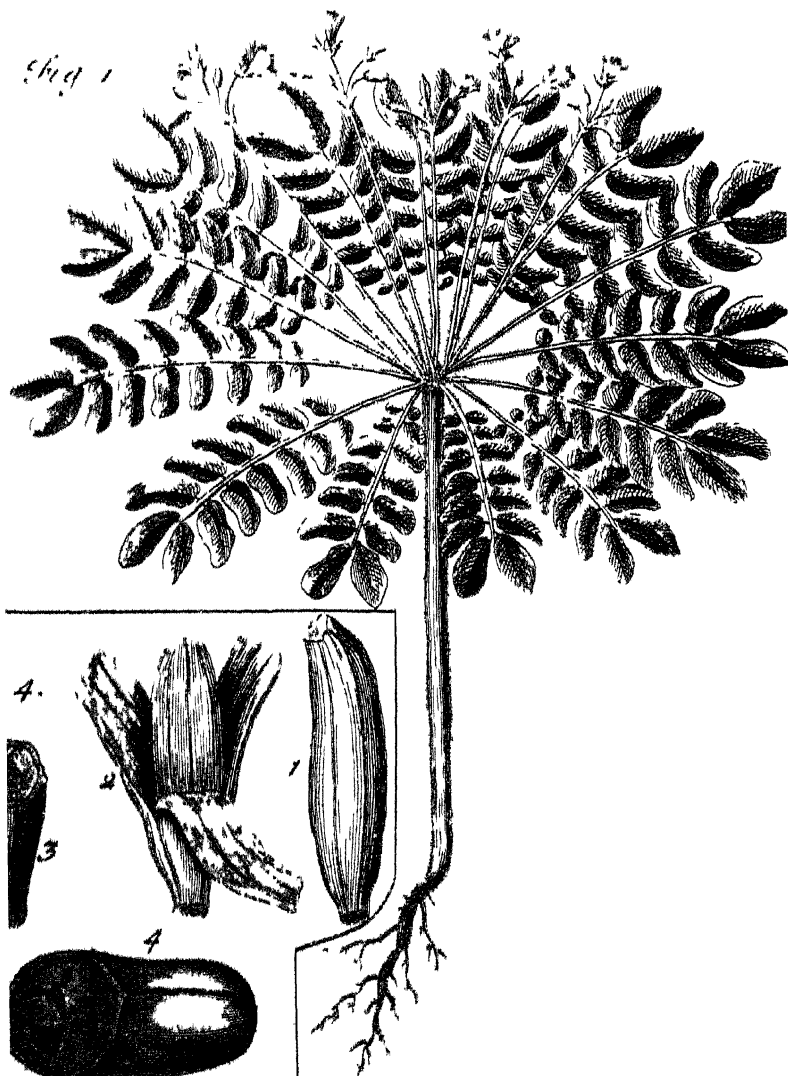
Fig.



Fig.

Cynodes javanica. *Limnatura* caule
rubescendo hirsute, flore luteo minore.

Fig. 1



Fruit of the Musa

The Year Letters

1. 甲 *Kia.*

2. 乙 *Y.*

3. 丙 *Ping.*

4. 丁 *Ting.*

5. 戊 *Hou.*

6. 己 *Ki.*

7. 庚 *Keng.*

8. 辛 *Sin.*

9. 壬 *Gin.*

1. The hour letters.

1. 子 *Tse...*

2. 丑 *Tcheou.*

3. 寅 *yn.*

4. 卯 *mao.*

5. 辰 *Chin.*

6. 巳 *Se.*

7. 午 *ou.*

8. 未 *Wei.*

9. 申 *Chin.*

10. 酉 *yeou*

11. 戌 *Sio.*

12. 亥 *hai.*

(1) 甲 *Kia.*

子 *Tse.*

(2) 乙 *y.*

卯 *mao.*

(3) 始 *Chi*

皇 *hoang.*

帝 *Ti*

(4) 庚 *Keng.*

辰 *Chin.*

(5) 黃 *hoang.*

帝 *Ti*

(6) 甲 *Kia.*

(7) 乙 *y.*

(8) 關 *a.*

逢 *Tong.*

(9) 施 *Tcheou*

蒙 *Mong.*

(10) 丙 *Ping.*

<p>(11) 彙 <i>Ieou.</i> 兆 <i>Tchao.</i></p>	<p>(13) 以黃芩其生 始物子本物 也立子原立 所者昔初</p>		
<p>(12) 子 <i>Ise.</i> 子 <i>ou.</i></p>	<p>(20) 丁 <i>Ting.</i> 亥 <i>hai.</i></p>	<p>(25) 玄 <i>hiuen.</i> (26) 天 <i>Cali.</i></p>	<p>(28) 胤 <i>yn.</i> 相 <i>Tchin.</i></p>
<p>(15) 敦 <i>Tun.</i> 非 <i>Tsang.</i></p>	<p>(21) 戊 <i>Uou.</i> 子 <i>Ise.</i></p>	<p>(27) 子 <i>filiius.</i> 聖 <i>Ching.</i></p>	<p>(29) 証 <i>yonq.</i> 正 <i>Tching.</i></p>
<p>(16) 羊 <i>yang.</i> (17) 斗 <i>Tsang.</i></p>	<p>(22) 甲 <i>Kia.</i> 申 <i>Chin.</i></p>	<p>(23) 祖 <i>Tsou.</i> 仁 <i>gin.</i></p>	<p>(*) 白 <i>Ise.</i> <i>à se.</i></p>
<p>(18) 于 <i>ou.</i> (19) 丙 <i>Ping</i> 辰 <i>Chin.</i></p>	<p>(24) 元 <i>yuen.</i> 癸 <i>quei.</i> 酉 <i>yeou.</i></p>	<p>(24) 皇 <i>huang.</i> 帝 <i>Ti.</i></p>	<p>王 <i>Wang.</i> <i>Regnans.</i></p>

PHILOSOPHICAL TRANSACTIONS

FOR THE

Months of *September* and *October*, 1730.

The CONTENTS.

I. *An Account of some uncommon Anastomoses of the Spermatic Vessels in a Woman, observed by*
- Cromwell Mortimer, M. D. R. S. Secr. &
Coll. Med. Lond. Soc.

II. *Memoirs communicated by Monsr. Garcin to Monsr. St. Hyacinthe, F. R. S. containing a Description of a new Family of Plants called Oxyoides; some Remarks on the Family of Plants called Musa; and a Description of the Hirudinella Marina, or Sea Leach. Translated from the French, by Mr. John Martyn, F. R. S.*

III. Typus

The C O N T E N T S.

III. Typus Eclipsæ Solaris observatæ Julii 15, S. N. 4, S. V. Anno 1730. Wittebergæ Saxonum, à Joh. Frid. Weidler, J. U. D. Mathem. Prof. Ordin. Reg. Soc. Scientiar. Pruss. Sodali.

IV. Observatio ejusdem Defectûs Solis habita Patavii, ab J. Poleno.

V. *An Explanation of the new Chronological Table of the CHINESE HISTORY, translated into Latin from the Original Chinese, by Father Johannes Franciscus Foucquet, Soc. Jes. Bishop of Eleutheropolis, and published at Rome in the Year 1730. Collected from two Accounts thereof, written in French, one sent from Rome by Sir Tho. Dereham, Bart. to the Royal Society, the other sent from Father Foucquet to Father Eustache Guillemeau, a Barnabite at Paris, and by him transmitted to Sir Hans Sloane, Bart. Pr. R. S.*

VI. *An Account of Mr. Mark Catesby's Essay towards the Natural History of Carolina and the Bahama Islands, with some Extracts out of the first three Sets. By Dr. Mortimer, R. S. Secr.*

I. *An*

- I. *An Account of some uncommon Anastomoses of the Spermatic Vessels in a Woman, observed by Cromwell Mortimer, M. D. R. S. Secr. & Coll. Med. Lond. Soc.*

EUSTACHIUS, that most accurate Anatomist, is the only Author I have met with, who has given us any Delineation of an immediate Communication between the Spermatic Arteries and Veins, during their Course along the Cavity of the *Abdomen*; which is distinctly laid down in his anatomical Tables (*Romæ in Folio 1714*) *Tab. XII. Fig. 1 & 3. Tab. XIII. Tab. XXV.* *Boerhaave* from him makes mention of these *Anastomoses* in his *Institut. Med.* § 642; and also cites *Leal Lealis* in his *Treatise Περὶ Σπέρματος Οργάνων* (*Lugd. Bat. 8vo. 1707*) *p. 18 ad 26*; where he fully refutes *de Graaf*, who denies these *Anastomoses*: but even *Leal* owns, he never saw them, and only argues for them from the Effect, and the close Union of the Spermatic Vein and Artery in one Covering as they run together. *Marchetti* in his *Anatomy (Hardevicæ 12º. 1656.) Chap. of the Parts of Generation in a Man*, asserts this *Anastomosis*, *p. 58*, but neither do I find that he ever saw them; nor have I hitherto conversed with any, even Anatomists, the most celebrated for their Injections, who had hit on a Subject, where these Passages were open enough to transmit the subtile Matter they inject with.

In the Beginning of the Year 1723, being at *Paris*, and at the *Hôtel Dieu* having an Opportunity of dis-

fecting various Bodies, I light on a female Subject, where these *Anastomoses* were as large as the spermatie Vessels themselves ; so that the Arteries being injected with a gross Mixture of Wax, Tallow and Vermilion, and the Veins with the same, only tinged with Smalt, the Injection ran out of the Artery into the Vein, and on the other Hand out of the Vein into the Artery, so that where one Vessel entered the other, the Matter injected was tinged purple. You must observe the Arteries were first injected with the red, and the Veins afterward with the blue Matter.

In this Subject what appeared most remarkable, was, that on the right Side were two spermatie Arteries A and B. One A, arose from the very Angle made by the Emulgent and the Trunk of the *Aorta descendens* C, which, contrary to the common Course, ran under the *Vena Cava*, and soon after it was got beyond it, sent out a lateral Branch, or *Anastomosis*, descending obliquely EF into the Spermatie Vein G, through which the red Matter penetrated into the Vein ; which being afterwards filled with Blue, became Purple allabout the Orifice of this Vessel at F, which seems to confirm *Eustachius's* Delineations, and shew they are no Fictions. This Artery A then descended as usual to the right Ovary H.

The other right Spermatie Artery B arose as usual out of the Trunk of the *Aorta* ; but at about half an Inch from its Rise, it sent out an *Anastomosis* IK, ascending obliquely into the Body of the *Vena Cava* D, through which a large Quantity of the red Matter passed, so as to tinge a very broad Place at K in the *Vena Cava* purple. About an Inch below this Orifice
was

was another *Anastomosis* L M, through which the blue Matter penetrated out of the Vein, and made the Contents of the Artery purple at L. The right Spermatic Vein had only this one *Anastomosis* M L, in all other Respects as usual. Here was something surprizing to see the Course of the Channel inverted, if the Blood ran from the Vein M towards L, into the Artery; but surely this must be from some Accident in the Injection, for it could never be so in the Person's Life; only indeed the oblique Rise of this Branch out of the Vein seems to shew, that the Blood ascending in the Vein would have its natural Direction into the Orifice of that Channel, or at least the Blood coming from the Artery would meet with a Stop, and so the two Streams retard each other.

On the left Side was but one Spermatic Artery N, and one Spermatic Vein O, which, as usual, inclosed in a common *Involucrum*, made their Way to the left Ovary P. Only the Artery N took its Rise out of the Body of the Aorta near the Angle made by it, and the left emulgent Artery, then ascending between the emulgent Vein and Artery, turned in an Arch at Q, over the left emulgent Vein, and so joined the left Spermatic Vein as usual, which rose out of the left emulgent Vein, as it often happens.

There was on this Side one Thing very uncommon, and not taken Notice of by *Eustachius* himself, which was a short *Anastomosis* R S (about a quarter of an Inch in Length) from the left emulgent Artery S, which making an Arch under the left emulgent Vein, was inserted into the anterior Part of it at R.

The small Branch arising out of the Aorta on the right Side at T, an Inch above the Emulgent, and its being inserted into the upper Part of the Kidney, is what we have many Varieties of in *Wesselingius's* Tables to his Book *De Structura Renum* (8vo. Lond. 1707) almost an Infinity of such Variations, and likewise of small Branches inserted into the emulgent Veins, as at V, are daily met with, and have been observed by many Authors.

Explanation of Tab. I. Fig. I.

A B, Two Spermatic Arteries on the right Side.

C C C, The *Aorta* descending, and the two Iliac Arteries.

DDD, The *Vena Cava* ascending, and the two Iliac Veins.

E F, L M, *Anastomoses* of the Spermatic Veins and Arteries.

G G, The right Spermatic Vein.

H, The right Ovary.

I K, An *Anastomosis* of the Spermatic Artery and *Vena Cava*.

N Q N, the left Spermatic Artery.

O O, The left Spermatic Vein.

P, The left Ovary.

R, S, An *Anastomosis* of the emulgent Vein and Artery.

T T, } Arteries and Veins dispersed on the Fat and
V, V, V, } Membranes enclosing the Kidneys.

- II. *Memoirs communicated by Mons. Garcin to Mons. St. Hyacinthe, F. R. S. containing a Description of a new Family of Plants called Oxyoides; some Remarks on the Family of Plants called Musa; and a Description of the Hirudinella Marina, or Sea Leach. Translated from the French, by Mr. John Martyn, F. R. S.*

A Description of a new Family of Plants, which I name Oxyoides.

THE *Oxyoides* is a Family of Plants, whose Flower and Fruit are altogether like those of the *Oxys*; that is, the Flower is compleat, regular, polypetalous and hermaphrodite; containing the *Ovary*, which afterwards becomes, as in the *Oxys*, a five-cornered Fruit, divided into five Cells, filled with small Seeds; each of which is covered by a Membrane, like a Hood, which opens, when ripe; and by an elastic Motion, makes the Seed leap out.

The true Characters therefore which ought to distinguish this Family from the *Oxys*, are, that the Leaves are disposed by Pairs along a Rib, without being terminated by an odd one, which makes them entirely resemble those of the *Tamarind*. That these Leaves are all gathered together, in an Umbel, on the Top of a naked Stalk: That they are not in the least Degree acid; and that they shew as great

a Sensibility, on being touched, as the Species of *Mimosa*.

The Species of this Genus are,

- I. *Oxyoides Javanica, sensitiva, caule rubescente, villoso, flore majore.* Tab. II. Fig. I.
- II. *Oxyoides Malabarica, sensitiva, caule viridi, glabro, flore majore.* Tab. II. Fig. 2.

Description of the first Species.

It is a Plant which grows usually to the Height of half a Foot. It is composed of a naked Stalk, of Ribs of Leaves, and of Pedicles of Flowers. Each of these Parts is of equal Length, and usually three Inches, when they are at their full Growth; and the whole is disposed in an Umbel.

The Root, which is almost as long as the Stalk, runs streight down, and sometimes obliquely into the Ground. It grows taper from its Neck, which is of the same Thickness with the Stalk. It is set with small Fibres, a little waved and white, and giving Rise to other pretty short Filaments. The whole Root is whitish.

The Stalk, which (as I said before) is usually three Inches high, arises sometimes streight, and sometimes crooked; sometimes wrinkled, and sometimes plain throughout its whole Length, pretty downy, or rather hairy, and always reddish in some Places. It is from a Line and a half to two Lines thick towards the Top, and usually something less towards the Bottom. This Stalk, which forms a kind of Button, or little Head at the Top, gives Rise at that Place to all the other Parts
of

of the Plant; that is, to the Ribs of the Leaves, and the Pedicles of the Flowers; which makes the whole Tuft resemble an Umbel.

The Ribs of the Leaves, which grow from the Top of this Stalk, go on encreasing till they equal the Length of the Stalk. They are about the Thickness of the treble String of a Violin, and equal throughout their whole Length. They are a little downy, after the same manner with the Stalk.

The Leaves, which grow by Pairs, occupy two thirds of the Rib; that Part which is next the Stalk being naked. The first Pair of Leaves is the least, and the last Pair always the largest. These are commonly half an Inch long, and the smallest are not above half the Size of the largest. These Leaves grow so near the Rib, that they seem to have no Tail. Their Base is always the broadest Part of the whole Rib, and always parallel to the Rib: The rest of the Leaf bends itself a little forwards. The Middle of their Length is usually their narrowest Part, and from thence they are gradually enlarged, and rounded at their Extremities. The Bases of all the Pairs are almost of the same Bigness, except the last, which has the Breadth on one Side only of the little Nerve, which traverses the Leaf, to avoid incommoding itself with its Neighbour; but to make Amends, the Leaves of this Pair are broader than the others, a little below their Extremities, especially outwards. They are all traversed lengthwise by a fine Nerve, or Thread, always bent like the Leaf on the Side of the last Pair. They are of a lively Green on the Inside, and a little whitish on the Outside. Their Plain is garnished with a great Number of very slender
Threads,

Threads, almost imperceptible, but parallel, which grow also by Pairs, and are placed at acute Angles with their little common Nerve, and grow smaller at the Edge of their Leaf. In short, their Position and Figure come pretty near to those of the *Tamarind*. The Number is usually from eight to ten Pairs, and they are as sensible on being touched, as those of the Species of *Mimosa*. They shut themselves up at Sun-set, as it were to sleep, after the same manner with the Leaves of the *Tamarind*. The Ribs are in Number from two to three Dozen; and the Pedicles of the Flowers are about a fourth Part fewer in Number: Both the one and the other appear of different Lengths, because the shortest are the youngest, but at last they usually grow to almost the same Length with the first. The opening of the Leaves is performed almost after the same manner with that of the Top of the Spikes of the Species of *Heliotropium*, unrolling like the Tail of a *Scorpion*. The Ribs and the Pedicles are a little hairy, as well as the Stalk. The Pedicles are of the same Thickness with the Ribs..

The Flower, though it seems to be monopetalous, is not so, any more than the Species of *Oxys*, which seem to be so too: Otherwise the Principles of Mons. *Vaillant* would be false, who has laid it down as a Rule, that in all monopetalous Flowers the Chives grow from the Sides of the Flower, and that those which grow from the Base of the Embryon, or rather from the Ovary, are always polypetalous. In short, if we examine them nicely, which no one has done till now, we may observe, that these Flowers have no *Anus* at the Base, but that the Petals, which are always five in
Number,

Number, have their Bases separated very distinctly one from another; and though they are reunited about the Middle, which makes them look as if they were of one Piece, yet they may be separated without tearing. *Tab. II. Fig. 3.*

The Petals of our *Oxyoides* are equal, they are from three Lines to three and a half long, and towards the Extremity about a third Part as broad as they are long. They are lightly cut in like a Heart at their Extremities. They are of a Lemon Colour, paler or deeper, according to the Moisture or Heat of the Season. Each of them has a small Streak running through their Middle Lengthwise. They are covered by their Empalement about two Thirds of their Height, and from thence they open in Form of a Bell. They are very tender, and last but the Space of one Morning.

The Empalement is one leaved: It is two Lines high, and the half of this Height makes the Thickness of its Base. It divides a little below the Top into five Lobes, very sharp at their Extremities. It is pale-green; it is regular, and a little hairy.

The Chives grow from the Base of the Embryon, being twice the Number of the Petals, five of them being higher than the other five. The highest reach up to about the Middle of the Petals. Their Summits are of the same Colour with the Petals, and the Chives of the same with the Empalement, or a little brighter.

The Ovary is very small and round, but a little furrowed into five Ribs, the Diameter of which is about one Third, or almost half a Line. It is crowned by five Teeth, which form the Body of the Stile.

This Ovary afterwards becomes a dry Fruit, of an oval Form, starred with five Furrows, of which the least Diameter is about one and a half or two Lines. This Fruit is divided into five Cells, and opens at the Top when ripe, and then expands itself by little and little to its very Base, and discloses small, round Seeds, lodged four together in each Cell. They are each of them covered with a little Hood, or very fine Membrane, which on the Encrease of the Bulk of the Seed, opens itself with Violence, and throws it on the Ground. The Colour of the Seed pretty nearly resembles that of the Seed of *Psyllium*.

Each Pedicle, during the Time of its Encrease, continually puts forth new Buds, and new Flowers, in the same manner as the Stalk continually puts forth at the Top new Leaves and new Pedicles. The Number of these Buds is usually five or six at the Top of each Pedicle, enlarged into a Head. These Buds grow, encrease and expand themselves one after another, which is the Cause that this Plant, when once it begins to flower, puts forth new Flowers every Morning, which are quite vanished in the Afternoon. The little Bunches of Buds, each of which adorns a large Pedicle, are encompassed with little Points, which compose a kind of common Empalement. In short, the little Pedicle, which is proper to each Flower, is slender, and a full Line long, so that its Length is equal to the Diameter of the Empalement.

The Diameter of the Flower, when it is most expanded, is four Lines.

The Petals make the Empalement expand itself a little : but when the Flower is faded, the Lobes of
the

the Empalement draw together, and form a pyramidal Body ; but when the Ovary grows bigger, and becomes the Fruit, ~~the~~ Lobes of the Empalement expand again, with but changing their Shape ; because the Body of this Empalement encreases its Diameter by the Effort which the Fruit makes within it.

R E M A R K S.

This Plant is very sensible of the least Cold : It loves warm and moist Places. It is found in the Island of *Java*, and probably in the other Islands of the *Sonde* and the *Moluccas*. When one touches its Leaves, they close immediately, and open again by little and little. The more they are warmed by the Sun, whilst their Soil is moist, the more impetuously they close against one another. The *Portuguese Indians* call it *Dormidera*, because, on being touched, it seems to sleep, by shutting up its Leaves ; or else, because some among them think it procures Sleep by being put under the Ear, as I have seen practised ; but I cannot ascribe this soporifick Quality to it, any more than I can recommend the hanging of *Mistletoe of the Oak* about the Neck for the Epilepsy. The Leaves of this Species of *Oxyoides* have no Acidity in their Taste, and give but a faint Tincture of Red to the blue Paper.

I thought this Plant curious and rare enough to be communicated to the curious *English* Botanists. I had the Pleasure to see a little while ago, in Dr. *Blair*, that the Flower of the *Oxys* was pentapetalous.

The Remark of Mr. *John Martyn*, F. R. S.

We are obliged to M. Garcin for his curious Description of this Plant, by which its Genus is determined. It is however by no means a new Species, having been described long ago by Acofta, and other Authors, under the Name of Herba viva. I have seen a fair Specimen of it in Sir Hans Sloane's Hortus Siccus, with which M. Garcin's Figure agrees very exactly. It was the first sensitive Plant known in Europe, and very different from those which are now brought from America, and cultivated in our Gardens under that Name.

The Flower of the Oxyoides, Tab. II. Fig. 3.

1. The Empalement.
2. The Flower, the Petals of which are joined together.
3. A Petal apart.

Remarks on the Family of Plants named Musa.

Almost all the Writers of Botany have looked on this Family as a Tree, on account of its Bigness, though it is tender, spongy, membranous and succulent, not at all hard or woody. Its Stalk is slender and supple, not able to keep itself upright, without a great Number of thick, membranous Sheaths, which cloath its whole Bulk, and defend it from the Injuries of the Weather. Besides, this Plant being annual bears Fruit but once, and then by Degrees perishes.

The

The Trees on the other Side, which are ligneous, hard and perennial, bear Fruit several times. The Bigness then of a Plant does not seem to be a Character sufficient to distinguish a real Tree from a Plant that is not one.

Again, the same Botanists have placed the *Musa* in the *Palmaceous* Class, which are all Trees, perhaps on account of this Plant's having but one Stalk, without any Branches; and because the great Leaves at the Top of it divide, when they grow old, in such a manner as to resemble in some Degree a Sort of *Palm*.

Having had an Opportunity in the *Indies* to consider this Plant better, I soon found that it justly belonged to the *Liliaceous* Tribe. It is known that the *Liliaceous* Plants have several Characters, which distinguish them very well. Their Roots are either bulbous, tuberous, or consisting of thick, fleshy Fibres: Their Leaves involve the Stalk, more or less at their Bases. The Substance of their Flowers is filled with silver Spangles; and lastly, their Fruits are always divided into three Cells. The *Musa* has all these Characters. Father *Labat* says in his Travels, that the Root of this Plant is a thick Bulb, round and massy, emitting Fibres. *Marcgrave*, who has given a full Description of this Plant under the Name of *Pacoeira*, has observed, that, at its first appearance, it sends forth two or three Leaves, rolled up like a Horn, which unroll themselves, and grow after the Manner of the *Cannacorus*. And, according to my Observation, the Fruit in all its Species, is constantly divided into three Cells, which is sufficient to shew, that it is a true *Liliaceous* Plant.

As *Marcgrave*, and the Authors of the *Hortus Malabaricus* have largely described this Plant, I shall content myself with only giving a Definition of this Genus, to make it better known.

The *Musa* is a *Liliaceous* Plant, with a monopetalous, irregular Flower, incomplete and hermaphrodite, composed of a Tube, which is filled with the Ovary, and a Pavilion divided into several Lobes, and forming a kind of Mouth. The Ovary, which adheres strongly to the Tube, is triangular, and crowned with five Chives, which grow from the Sides of the Flower; it has also a Stile, which is terminated by a little Head. It afterwards becomes a soft, angular, long, crooked Fruit, something like a *Cucumber*. This Fruit, when ripe, is fleshy, and divided into three Cells, filled with a mucilaginous Pulp; under which the Seed is placed along a *Placenta*, which serves as an *Axis* to the Fruit.

This Seed is small, round, edged with an almost imperceptible Leaf. The Flowers grow at the End of the Stalk, in Knots disposed in a Spike. Each Knot is loaded with two Rows of Flowers, covered with a membranous, hollow, thick, oval Covering, which serves them for a common Empalement. In the *Hortus Malabaricus* there are three Plates, which give a good Representation of the Plant, its Flower, and its Fruit; but I have observed three Defects in them: 1. That the Flower is not represented in its most perfect State, but almost withered, and so its Pavilion too much cleft, which makes the Flower seem tetrapetalous; for the Flowers of these Plants divide when they are old, as well as the Leaves. 2. That the three
Cells

Cells are not shewn distinctly, in the transverse Section of the Fruit. 3. That the Seed is not represented at all.

This *Genus*, or Family, comprehends twenty or twenty-five Species, known to the *Indians*, the Differences of which are usually taken from their Fruits. This Plant does not perish before it has ripened its Fruit, whence it might last longer in a temperate Climate, cool enough to retard its Fruit.

The Bark of the Fruit is formed of the Tube of the Flower ; and the Lobes dry away during the growth of the Fruit.

*The Fruit of the Musa represented entire,
Tab. II. Fig. 4.*

1. The same half stripped of its Bark.
2. Cut through the Middle.
3. Cut transversely, distinguishing the three Cells and the Seeds.

Another Species of *Musa* cut transversely, represented in the *Hortus Malabaricus*, but having the Cells better distinguished here. The six black Points are the Seed.

Hirudinella Marina, or Sea-Leach.

Having observed on the Sea a little Insect shaped like a small Worm, which I found in the Stomach of a *Bonite*, where it was strongly fastened, I was desirous to examine it with regard to three Things, which excited my Admiration. 1. Its Shape. 2. The Place
of

of its Abode. 3, and lastly, The Mechanism of its Rest and Motion.

Its Shape, which was a Novelty to me, and which I suspected no one had yet observed, came very near that of a *Leach*; it had all the Motions of that Animal, together with some of its own. The *Figure A* represents this Insect in its natural Bigness, and according to its most constant Dimensions; wherefore I shall not stay to make so particular a Detail of them. I shall content my self with observing in general, that its Body is round throughout its whole Length almost, but a little flatted towards it Belly B; so that its Circumference, taken according to its Thickness, is almost elliptick. It is adorned all along with little circular Furrows parallel to each other, and very close together, but so fine, that one can scarce perceive them without a Microscope. It is of a greyish Colour, and its Body is a little transparent. One sees on its Back, as well as underneath, two black Lines, which begin by an acute Angle towards the Neck, and running through the whole Length of the Body, seem to be terminated towards the *Anus*. These Lines are not upon the Skin, as one might imagine at first Sight, without sufficient Attention; they are Tubes, or Bowels, which serve for Nutrition or Chylification, which appear through the Integuments. I shall divide the Length of this little *Leach* into two Parts, distinguished by the Center of a little Protuberance C, which is under its Belly, and is a muscular Body, in Form of a spherical Bladder. These two Parts of the Body are in the Proportion of Four to Three. I shall call them the fore Part and the hind Part. This Distinction is necessary

cessary, as well with regard to the different Motions of these two Parts, as to this Protuberance, which separates them at their Beginning. This little Protuberance, when it is in its greatest Extension that the Animal can give it, is of the same Form with a little spherical Air-Pump, and has all the same Properties, as I shall explain by and by. Its Situation is under the Body, and its Diameter is such as appears in the Figure. I know not to what I can compare this Part better than to the Cup of an Acorn, with the Mouth a little contracted. The Head E, which makes the smallest End of this Worm, represents no Part worthy of Observation, except a hollow Body underneath, of a conical, or almost hemispherical Figure, which seems to serve it for a Mouth to suck, as well as to fasten itself on the various Bodies which come in its Way, after the manner of the other *Leaches*.

The Belly B is of a dark Colour, because several Bowels, which are contained in it, are filled with a thick, black Liquor, which makes it look as if the Skin was of that Colour. The fore Part C E is variously shaped, according to its different Motions; sometimes it prolongs itself, and then it becomes slender, the Diminution being made by Degrees up to the Head; and sometimes it contracts itself, and then the Thickness encreasing, it becomes all of an equal Bigness. The hinder Part C B does not change its Figure, because it moves but slowly, and very seldom. The Motion of the fore Part is of three Sorts; Prolongation, Contraction, and the making itself round on all Sides. The Protuberance also is endued with two Motions, Extension and Undulation, which is made

from the Center to the Circumference. When this Insect stops itself any where, it holds strongly by means of this Protuberance. Before it applies it, it shortens it, by withdrawing the Edges, or the Circumference towards its Centre; and after it has applied the Orifice of its Protuberance upon the Surface of any Body, it lifts up a little the Center, or Bottom, towards its own Body; afterwards it swells it, and stretches it on all Sides, according to all its Dimensions. This Protuberance thus applied, stretched and void of Air, makes that which endeavours to enter, press it externally on all Sides, and hold it so fast, that it is above the Strength of the Animal to separate it from its Place where it is applied. This Animal being thus fastened, and detained by its Protuberance, its fore Part is always in Motion, whilst its hinder Part remains almost immoveable. It stretches its Head sometimes to the Right Hand, sometimes to the Left, by lengthening and shortening its fore Part, which bends and streightens itself very frequently. I have marked the Excent of all these Motions by prickd Circles of different Bignesses, all which touch one another at one Point of their Circumference, at the Center of the Protuberance, which is as it were the Beginning and fixed Point of all these Motions. These Circles thus disposed are excentric, contained one within the other. It is by these different Motions that this Insect performs the two Functions which are necessary to it.

1. To find the most convenient Way when it has a Mind to change its Place.
2. To discover the most proper Place, either upon or within the Body of the *Fish*, where it finds itself fastened, to suck the Blood,

or

or any other Juice proper for its Nourishment. In fine, when this little Animal desires to change its Place, it makes use of its Protuberance and its Pump, which is the little Hollow under its Head, and seems to serve it for a Mouth: It applies this Part to the Place D, whither it would remove its Body, and after being prolonged by it's fore Part to reach the Place, where this Application should be made, it draws its Protuberance and Pump together, by bending its fore Part circularly, after the Manner of some *Caterpillars*. Its Protuberance being applied, it loosens its Pump, and prolonging itself, applies it to another Place more forward: The Pump being fastened, it bends itself circularly again to bring the Protuberance up to it, and apply it as before. By this we see that the Worm prolongs itself to apply its Pump, and contracts itself to do the same with it's Protuberance. Thus these Motions and Applications are made successively, and as often as there is Occasion. The hinder Part fastens itself to nothing, but is always drawn by the Part which goes before it.

I found this Worm in the empty Stomach of a Fish, called by the *Portuguese*, *Bonite*: It was fastened by its Protuberance upon one of the Folds of the inner Membrane of this *Viscus*. This little *Leach* made a pretty deal of Resistance when one endeavoured to pluck it away.

I shall add to this Description some Reflexions and Conjectures, formed on the *Phænomena* which I have observed in this Insect. I have observed, 1. That this little Animal did not live above two Hours after it was taken out of the Place where I found it. 2. That it

grew languid as soon as it was exposed to the Air, and recovered some Vivacity as soon as it was put into a little Sea-water. 3. That, as soon as it was put in the Water, it sent out from its Mouth a little green, almost imperceptible Thread, which kept itself suspended in the Water, and was about as long as its Body, and was as fine as the finest Thread of a Spider's Web: After this Thread was put forth, it emitted also from the same Place some little Bubbles of Air. 4. That the Body of this Worm decreased in Bulk by little and little as long as it was alive, and that, after its Death, this Diminution either ceased, or became less sensible. 5. That having cut its Belly through with a Pair of Scissars, as soon as it was dead, and squeezed it, there came out a black, thick Liquor.

From these Facts we can draw but very slender Consequences. It is certain that this Insect cannot live out of the Water; so that one cannot imagine it could live in the Stomach of any Land-Animals, unless they came near the Nature of the Amphibious; for the Worms which grow upon, or within the Bodies of Animals, ought to be of the same Nature with them, with Regard to the Elements in which they live. Our Worm seems to be incapable of living any where but in the Bodies of Fish, seeing it kept alive but a very little Time in the Sea-water, in which I put it, having been exposed to the Air but one Moment at two different Times; which was not sufficient to alter its Parts, and cause its sudden Death. The almost immediate Diminution of its Bulk in the Water is another Mark that it cannot live in the Sea out of the Body of the same Fish; for if the Water, which

which was more natural to it than the Air, was injurious to it, much more would the Air, to which I exposed it, have been prejudicial. The fine Fibre which it put forth, and the Decrease of its Bigness, were Signs that it suffered some Uneasiness. Lastly, The black and thickish Juice, which came out of its Entrails, could be nothing but some half coagulated Blood, which it had sucked in the Stomach of the Fish. Its Pump, which it uses after the same Manner with *Leaches*, is a strong Proof that this Insect cannot take its Nourishment by any other Power than that of Suction. Its residing in the Stomach, or some other Part of the Body, can be for no other Reason but to nourish itself with the Blood, or some other Juice of the Animal.

As the *Bonite* is a Fish of Prey, living on other smaller Fishes, it is probable that this little *Leach* usually fastens itself on those which come into the Stomach, and that it lives on their Blood.

The Stomach, in which I found it, was quite empty, so that it was probably as hungry as the *Bonite* could be; for this Fish is not easy to be caught but when hungry. However, it was the first Time I found it so very empty, though I have seen a great Number opened.

One may conjecture, when the Stomach of the *Bonite* is empty, and this *Leach* is in it, that it being almost starved, fastens its Pump to the Membrane of the Stomach, to suck Nourishment from it; and if so, it must cause a painful Sensation of Hunger in the Fish.

Lastly, It might have happened that this little *Leach* came out of the Body of some small Fish into that of the *Bonite*, which had swallowed it. I made this Observation the 28th of *July*, 1724, in a Voyage from *Batavia* to *Bengal*.

Explanation of the Figure Tab. I. Fig. 2.

- A, The Body, in its natural Bigness.
 - B, The Belly, through which appear some black Lines, which are its Entrails.
 - C, The Protuberance, with which it fastens itself.
 - D, The Places where it places the Pump and Protuberance, when it moves along.
 - E, The Head, under which is the Pump.
- The pricked Circles are to mark the Extent of the Motions of its Head and Belly.

III. Typus Eclipsæ Solaris observatæ Julii
15, S. N. 4; S. V. Anno 1730. Witte-
bergæ Saxonum, à Joh. Frider. Weidler,
J. U. D. Mathem. Prof. Ordin. Reg. Soc.
Scientiar. Pruss. Sodali.

Tempus Ver.

antem.

H. ' "

3 56 0

59 0

Phases Eclipticæ.

Digit. Min.

Sol oritur post Nubes.

5 & paulo plus Sol latet
post Nubes.

H.	'	"	Dig.	Min.
4	10	30	6	55
	26	0 ^N	6	30
	33	0	6	0
	38	0	5	30
	43	30	5	0
	47	0	4	30
	50	15	4	0
	53	30	3	30
	57	0	3	0
5	3	30	2	0
	7	0	1	30
	10	30	1	0
	13	0	0	30
	15	30		Finis.

A N N O T A T.

I. Sol oriens figuram orbis monstrat ellipticam: diameter verticalis duobus digitis, five sexta sui parte contractior apparet horizontali.

II. Memorabilis erat conspectus orbis Lunæ aspero margine præditi, quoad partem quæ in occasum spectabat. Distincte enim cernabatur H. 4. M. 3. Vallis $\frac{1}{15}$ diam. Lunæ profunda & $\frac{1}{12}$ ejusdem diam. circiter longa. In progressu eclipseos asperitas limbi Lunæ minuebatur, & adhærente eidem fascia cœrulea abscondebatur. Hæc enim fascia sensim sole altius surgente dilatabatur. Tum præter colorem cœruleum etiam puniceus Lunæ proprius incumbens in oculos incurrebat, & circa finem deliquii fasciæ coloratæ spissitudo trigessimæ

trigesimæ sextæ parti diametri Lunarîs par videbatur.

III. Præterea juxta Lunarîs disci marginem coloratum perpetua Luminis solaris commotio notata est.

IV. Observatio ejusdem Defectûs Solis habita Patavii, ab J. Poleno.

ORIENTE Sole, Nubes tenues Finitorem quasi cingebant: quibus deinde evanescentibus, aer tantillum nebulosus fuit, ut maculæ solares haud satis distincte apparerent.

<i>Digiti</i>	<i>Temp.</i>	<i>Ver.</i>	
<i>Obscur.</i>	H.	'	"
			<i>July 14. 1730. S. N.</i>
4	16	46	12
3½	16	48	7
3	16	50	36
2	16	57	24
1	17	1	20
½	17	3	29
Finis	17	6	8
totius			
Obscur.			

V. *An Explanation of the new Chronological Table of the CHINESE HISTORY, translated into Latin from the Original Chinese**, by Father Johannes Franciscus Foucquet, Soc. Jes. Bishop of Eleutheropolis, and published at Rome in the Year 1730. Collected from two Accounts thereof, written in French, one sent from Rome by Sir Tho. Dereham, Bar^t. to the Royal Society, the other sent from Father Foucquet to Father Eustache Guillemeau, a Barnabite at Paris, and by him transmitted to Sir Hans Sloane, Bar^t. Pr. R. S.

THERE have been spread in *Europe* divers Opinions concerning the *Chinese* Antiquity, which are very false, nay some very absurd. I place in the first Rank of these false and absurd Opinions that which traces back the Origin of the *Chinese* Nation beyond our Account of the Creation of the World; likewise others which would fain place the Beginnings of the *Chinese* Empire before the Deluge. Such *Chimeras* deserve not the Pains of refuting. They are equally repugnant to good Sense, the Rules of Criticism, and to Religion.

There are some more moderate Opinions, which bring nearer to us the Beginnings of the *Chinese* Monarchy: these may be reduced to three.

H h h

The

* One of the Original Chinese Tables printed at Canton, was presented to the Society by Sir Tho. Dereham, and is now deposited in their Library.

The first places these Beginnings under one *Fou hi*, whom it makes reign 2952 Years before *Jesus Christ*.

The second places them under one *Hoang Ti*, 2697 Years before the vulgar *Æra*.

The third in fine puts them under one *Tao*, 2357 Years before the Birth of our Saviour.

This *Fou hi*, this *Hoang Ti*, and this *Tao*, who are supposed to have been so many *Chinese* Princes, are mysterious Names of heroick Persons, who never were in *China* : this is elsewhere demonstrated. Wherefore these Opinions, though they appear less fabulous, are not less remote from Truth.

It is manifest, that not one of these Opinions can be made agree with the vulgate Translation of the Bible. Recourse must be had to the Septuagint, which indeed would be no Inconveniency ; seeing the Numbers of the Vulgate and those of the Septuagint are equally current in the Church.

But to speak in general, these various Opinions make the Epoque of the *Chinese* History remount higher than is true. Their Diversity already gives room to perceive their Incertainty, and how little Solidity there is in the Foundations, whereon each of them stands.

The Author of certain Memoirs on *China*, that have made some Noise in the World, declaring for the Chronology, which fixes the true Epoque of the *Chinese* History at *Tao*, has not feared to advance, on this Chronology, these five Propositions.

1. That it is very much followed, and hath many Circumstances to support it.

2. That it is not fabulous in its Beginnings, as that of the *Romans* and *Grecians*.

3. That it is established on many Observations of Eclipses, which are marked therein, and are found every conformable to the Astronomical Calculations of the most learned Astronomers of the later Times.

4. That all the Parts of the ancient *Chinese* History have been writ by Authors contemporary with the Kings, whose Lives they have left us.

5. That *Confucius*, whose Authority ought to be of great Weight on account of his Probity and Virtue, never called this Chronology in Doubt, but always supposed it very true.

The Author of the Memoirs has but copied after other Writers more ancient than himself. A Reader who has never been out of *Europe*, and sees those Things affirmed with so much Confidence, thinks there is no Reason to doubt of them. Thus has the Fable been introduced without Opposition, by Degrees it gained the Ascendant, and is so established at this Day, that one scarce dares attack it.

Nevertheless the following Propositions are indubitable, and contradictory to the five Propositions just now cited.

1. The Chronology in question is made up of Parts ill linked together, and that have no Connection; and abounds with absurd Contradictions.

2. It is entirely fabulous in its Beginnings and Progress; entirely fabulous in its Principles, and in the Consequences drawn from thence.

3. It is not built on any Observation of Eclipses: The Eclipses marked therein, and the other Astronomical Characters by which the Author would fain establish it, are contradicted by the Tables and Calculations of the most learned Astronomers of these later Times.

4. The ancient Kings, whose Lives he pretends to have, are esteemed in *China* truly chimerical Men : These pretended Lives have not been writ by contemporary Authors.

The Chronicle, which contains this Texture of Fictions, is the Work of a Person named *Se ma Tſien*, who was born 146 Years before the vulgar *Æra*, viz. more than 2000 Years after the Time wherein *Tao* is placed, who is made first Emperor. If some Authors can be quoted for Warrantees of what this *Se ma Tſien* advances, they were modern to the Time when he wrote : these Authors oppose each other : the Style of some of them is infinitely obscure ; and in the Bottom *Se ma Tſien*, as he himself acknowledges, had nought for the principal Ground-work of his nauseous Chronicle, but miserable Rhapsodies collected at Hazard, or popular Traditions which he had gathered, without understanding them, as he rambled over some Provinces. This Work is in most Points contradicted by the *Kings**, a Book truly ancient, and of great Authority.

5. In fine, there is nothing that is certainly of *Confucius* to serve as Proof for a Chronology manifestly imaginary. It no where appears that he had ever examined it. This Philosopher has left nothing in Writing ; for it is not worth while to reckon a small Chapter of a few Lines, which is ascribed to him without giving good Reasons why, and is in the Front of a Book entitled, *Ta hio*, or Great Doctrine. All the rest that goes under the Name of *Confucius*, is read in modern Treatises, where he is made to speak ; Treatises which appeared in the World many Ages after the Death of
this

* Kang mou.

this Philosopher, and of Consequence Apocryphal, suspected, and for the most Part rejected by the most able of the *Chinese*, and full of Circumstances which these learned Men deny, or at least call in Doubt. Moreover, if these Treatises deserve any Credit, some Things are found therein, even under *Confucius's* Name, which quite overturn the chronological System of *Se ma T sien*. Are these Titles to be boasted of as Testimonies of *Confucius* in Favour of a Chronology, on which, there is just Reason to believe, he never so much as thought ?

Notwithstanding so many evident Proofs of a palpable Falshood, this Chronology of *Se ma T sien* is at this Day received in *China*. It was at first neglected there: but Error insensibly prevailed. The Multitude among the *Chinese*, as among us, easily embraces the most groundless Opinions a great Name imposes. *Se ma T sien* had the Employ of Historiographer of the Empire: He was the only Person that could be followed then. He soothed the Nations Pride, making not only its Origin, but even the Beginnings of its Monarchy ascend backward to very remote Antiquity. He annoblized it by a Croud of Heroes, to whom he gave Birth in its Bosom: He enriched it by an Infinity of Incidents, invented it is true, but such as were deemed instructive and glorious to the *Chinese* Name. After the Loss of the Libraries burnt under *Chi hoang*, there was not more than an Age elapsed when he composed this History: such a Work was a sort of Consolation: It was regarded as a Treasure: Men ran eagerly after a Book that seemed to present such fine Things: Its Stile was pleasing, being Laconic and strong: It was read then, and in
reading

reading believed without much Examination, because there was Pleasure found in giving Credit to it.

Thus did the agreeable Poison insinuate itself: The very Learned, or those who thought themselves such, were infected thereby. But *China* has its Critics as well as we: There are some of them clear-sighted enough to discern Fictions; and firm enough not to give themselves blindly up to the most propagated Errors.

Several in after Times opposed *Se ma Tsen*, taxed him with excessive Credulity, and reproached him for his monstrous Over-sight. Nay, some laying aside his Authority, have boldly abridged the Times, and fixed the true Epoque of their History at a small Number of Centuries before *Jesus Christ*. Among these is the Compiler of a new Chronological Table of the *Chinese* History, which has lately appeared here in *Latin* on a large Sheet of Paper. It is a Translation published by Father *Fouquet, Soc. Jes.* the present Bishop of *Eleutheropolis*, who hath lived near twenty-three Years in *China*. The *Chinese* Original from which the Translation was made, is owing to the learned *Nien hi yao*, a *Tartar*, illustrious by Birth and Merit, and Viceroy of *Canton* in the Year 1724*: For the *Tartars*, since their Conquest of *China*, are become well versed in Sciences, and especially in the History of the Empire they conquered.

Yet this Gentleman is not the Author of the Chronological System he has here drawn up. He himself
: : tells

* His Father possessed the like Post, and in the Year '17 2 his Brother w
Tsong Tou of two Provinces, a more considerable and more important Em-
ploy than that of Viceroy.

tells us, he has taken it from the most valued historical Work in his Country *. What renders this Writer Praise-worthy, is his ranging his System in a beautiful Order, which gives an extream Facility of seeing at first Sight the Series of the Dynasties, or Imperial Houses, the Names and Succession of the Emperors, the Beginning, End and Duration of each of their Reigns.

However, this is not the only Advantage of this new Table: The ancient Chronology of *China* is therein reduced to its true Beginnings. The most remote Epoque of this Chronology, according to *Nien hi yao*, does not surpass the first Year of a Prince called *Guei lie wang*, who began his Reign 424 Years before the vulgar Æra. Some there are, who think this Epoque might still be brought nearer to us; not to fix there the Origin of the Nation, which, for strong Reasons, may be traced back to Time near the Deluge; but because from much later Date only, doth any Certainty appear, of whatever is pretended to have befallen this famous People. † *Se ma quang* and *Tchu bi*, the two gravest Historians *China* has produced, were of this Opinion. The first flourished in the Year of *Christ* 1061, ‡ the second about the End of the twelfth Century. They have both omitted whatever is before the Time of *Guei lie wang*, nor would they mention ought of it in their Histories: Nay, they have not begun them till the twenty-third Year of *Guei*

* *China is now the Country of these Tartars who were born there since the Conquest, that is about ninety Years since.*

† *Se ma wen, or Sema wen Kong.*

‡ *Sæculo 11^o, vel 12^o. Sæculo 13^o.*

Guei lie wang, somewhat later than *Nien hi yao*, who begins with the first of this Prince's Reign. It is on the Example and Authority of these two illustrious Philosophers that *Nien hi yao* has relied in suppressing what precedes.

By fixing this Epoque at *Guei lie wang*, fabulous Times, and a thousand Errors and Absurdities current in *Europe* concerning three Imperial (absolutely imaginary) Families, and reigns anterior to, but no less chimerical than these Families, are retrenched. These Errors will soon vanish of their own accord; so that the Subject of so much laborious, but useless Lucubration and Study, will at length cease: a worthy Motive for congratulating the learned World.

This is not all; we are still particularly obliged to the ingenious *Tartar*, for having found Means to place in his Table the Cycle of sixty Years, called *Kia Tse*, so much esteemed by the *Chinese*, that it is as the Soul, Link and Foundation of their whole Chronology: a Point which requires Explanation.

The *Chinese* are not acquainted with our Olympiads; but from Time out of Mind they have used this Period of sixty Years, which is of as great Service at least as the Olympiads, or the most celebrated Periods among the *Greeks*.

As we mark the Incidents of ancient History by the Years of the Olympiads, so the *Chinese* mark what has happened in their Country by the Years of this Revolution. Our Chronologers say, for Example, that the *Peloponnesian* War began the first Year of the twenty-seventh Olympiad; that *Alexander* was born the first Year of the one hundred and sixth. According to the *Chinese*, the Prince under whom
the

the great Wall * was finished, began his Reign the fifty-second Year of a Cycle, which is found to be the fourth in this chronological Table, reckoning from the Cycle of the general Epoque inclusively. This general Epoque, as has been already said, is the first Year of *Guci lei wang* †.

Now as the Years of the Olympiads had no proper or peculiar Names, they were distinguished only by their Order of first, second, third and fourth: But every Year of the *Chinese* Cycle is marked by two Letters, which make up its proper Character, and distinguish it from the other fifty-nine. Thus the first Year is called (1) ‡ *Kia Tse*, and gives its Name to the whole Cycle. Thus the fifty-second Year of the fourth Cycle, in which the Prince, who finished the great Wall, began his Reign, is called (2) *y mao*. This Prince, after bloody Wars, became Monarch of *China*; and then abandoning himself to such impious Pride, as the Philosophers reproached him with, caused himself to be called (3) *Chi hoang Ti*, as much as to say, *the first Master, the first Emperor reigning of himself*; for this is the real Signification of these Characters well analysed; and those glorious Titles belong to God alone in the ancient Monuments. This unheard of Usurpation happened in the twenty-sixth Year of his Reign, which is the seventeenth of the fifth Cycle, and is there called (4) *Keng Chin*.

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* This great Wall justly passes for one of the Wonders of the World, beginning at the Eastern Sea, and extending to near Thiber, above four hundred and fifty French Leagues.

† The Method of finding this Epoque on the Table is given hereafter.

‡ Vid. Tab. III. Fig. 1, &c.

It is thus that all the Years of the Emperors, for above two thousand Years, ' have Names in History common to them with the corresponding Years of the Cycle: and these Names common to both, are a Sort of Link which unites the Years of the Emperors to the Cycle, and thereby prevents Confusion. Hence we see how the Cycle among the *Chinese* is the Knot and Basis of all their Chronology.

Here a Question naturally arises, concerning the Signification of these Characteristics, which distinguish the Years of the Cycle and Emperors: for it must be pleasing to the Reader to dive into their true Sense.

It is to be wished it were as easy to answer this Question as it is natural to propose it: But it regards Characters so infinitely different from ours, that their Nature or Origin have never been well extricated; nor has there been any Principle hitherto established for their Explanation. Wherefore to endeavour now to penetrate their primitive Signification, would be the same thing as to attempt walking without a Light in an unknown dangerous Road, in a dark Night. Yet since an Answer must be given, to lead the Reader by Degrees to the Knowledge of so new a Subject,

We must remark, *First*, That it is not possible to give these Names any Translation. *Kia Tse* will still be *Kia Tse* in all Languages; *y mao* will still be *y mao*; *Keng chin*, *Keng chin*, and so the other fifty-seven Names: and this no *European* that understands the *Chinese* Tongue will contradict.

Secondly, That these Names are composed of two Sorts of Characters* very famous among the *Chinese*,
who

* See the Characters in the Plate annexed, Tab. III.

who get them by Heart in their Youth, and employ them on a thousand Occasions. These of the first Sort are ten in Number, and are called the *Year-Letters*; these of the second, twelve, and are named *Hour-Letters*.

Thirdly, That these two Sorts of Characters are combined, by repeating the ten *Year-Letters* six times, and the twelve *Hour-Letters* but five times; for six times ten, and five times twelve equally make sixty: and from this Combination result sixty Names for the sixty Years that compose the Cycle.

These three Points well comprehended suffice for the Use and understanding of the chronological Table: and the Reader would do well to stop here.

It may be objected by some, that this Erudition is unpleasant, because it enlightens not the Understanding; the Names remain unintelligible, and the Reader's Curiosity is not satisfied. But will it be more so, by adding what the *Chinese* take out of their Traditions?

I pass by the Abuse made of these twenty-two Letters by judiciary Astrologers. It is a Subject apart that would carry one too far: Wherefore I shall keep within the Bounds of what the *Chinese* hold, and give for most authentic.

They pretend that these twenty-two Letters were invented by a very ancient King, whom they name (5) *Hoang Ti*, in order to determine the Beginning, Progress, End, and successive Periods of a great Year; for they have one which includes a certain Number of Ages, though its total Duration be no where distinctly marked.

They say the great Year is successively at *Kia*, at *y*, and at *Ping*.

Now it is no easy Matter to determine the Extent of these different Parts of the great Period (for there is room to conjecture that they are unequal) how long, for Example, lasts that which commences at (6) *Kia*, that at (7) *y*, and so of the rest; nay, it is perhaps impossible, for want of certain Principles, the Knowledge of which is entirely lost.

When the Year was at *Kia*, which seems to signify when it began, this Point of Time, according to Tradition, is called (8) *O song*; when it was at *y*, this is called (9) *Tcheou Mong*; when at (10) *Ping*, the Name given to it was (11) *Jeou Tchao*.

Every one of the other nineteen Letters has in this manner a Word for its Device; but as it is plain, that all these Words are very strange to *European* Ears, and that those which remain are as obscure and barbarous as *Kia Tse*, *Y mao*, *Keng chin*, it is best to omit mentioning them.

Nevertheless one should not easily believe that these Words are void of all Meaning, or that the Letters, whose Names they are, are Figures made at Hazard, or arbitrarily imagined. The Inventor of these Names must have proposed himself some End.

It is already known in general, and is demonstrated elsewhere, that the Characters preserved by the *Chinese*, but much more ancient than them, are true Hieroglyphics.

It is likewise known, and strongly demonstrated, that the Doctrine veiled under the Appearance of these Hieroglyphics, is very mysterious and sublime: and it is

unreasonable to regard as Nonsense, and reject such as we understand not, purely because we do not understand them.

And indeed when we closely examine the twenty-two Letters in question, we perceive in several of them somewhat very mysterious, which the *Chinese* themselves present us with without understanding them, For Example, (12) *Tse*, the first of the *Hour-Letters*, signifies with the *Chinese* both the Moment of Midnight and a tender Babe just born (wrapt up in his Baby-Cloaths.) *Ou*, the seventh of the *Hour-Letters*, signifies the Moment of Noon, and a Man lifted on a Cross. This Letter signifies Noon, according to the Primitive Meaning, which still subsists without ever having been disused. It also signifies a Man lifted on a Cross, as is evident to the Eye of any Person, who has the first Tincture of the Characters. I know some Difficulty may be raised on this Point, but it shall be resolved in its proper Place.

Where have this People got such Ideas? They are incomprehensible to them at present, and yet (it is strange) they preserve them preciously, and use their utmost Endeavours to find out the Sense of them, but to no Purpose.

That *Tse* signifies both Midnight and an Infant just come to the World; that *Ou* marks Noon and a Man lifted on a Cross, are Facts cited as they are found in the *Chinese* Vocabularies, without Comments, Conjectures, or any other of ones private Thoughts; which should be the more surprising to the Reader.

It will encrease the Surprise to reflect on a *Chinese* Axiom, the Sense whereof is, that the Heavens opened at the Hour of *Tse*, which, according to the foregoing Exposition, ought to be understood of the Moment of Midnight.

And in order to raise the Admiration a Degree higher, *Tse*, which signifies an Infant, is literally and properly used to signify *Son*. Now let the Reader give Attention to the surprising Words of a *Chinese* Writer on this Son.

“ (13) The first Instant, says he, of the Production of Things, their Principle and Origin came from the Son. The Son is the Cause by which all Things had a Beginning.

When the Year is at (12) *Tse*, that is called (14) *Kouen Tun*. This *Kouen*, in the common Acceptation, signifies Work, Pain, Grief. *Tun* signifies being reduced to great Anguish. The Application of these Words to the tender Babe, to the Son lately born, produces a Meaning, which by being too intelligible and too beautiful, raises Wonder.

When the Year is at *Ou*, it is called (15) *Tun Tchang*. We have seen that *Tun* signifies Anguish, Affliction. To have the true Signification of *Tchang*, Recourse must be had to the Analysis, as on infinite other Occasions.

The Analysis gives (16) *Tang*, the Emblem of a Lamb, and (17) *Tchang*, which signifies to divide, to pierce. Thus at the Hour of Noon, marked by (18) *ou*, that is, a Man on a Cross, the Lamb was pierced.

If the Reader is struck with these Ideas, new to him as they must be, let him not attribute his Surprise to the Writer hereof, seeing it was the Obligation of answering the Objection above-mentioned that urged him thereto.

But let us drop this Subject, too fruitful in Paradoxes. What has been alledged is sufficient to verify a Word in the *Latin* Instructions at the Head of the Chronological Table, *viz.* that the Characters by their Combination form the Cycle, are very profound. To enter upon the Explanation of the rest, would lead us into new Depths, the Discussion whereof would require long and critical Dissertations. It is well the understanding these Mysteries is of no Service to the Use of the Table in Hand. Wherefore let us return to the Cycle itself, such as it is at present in the Hands of the *Chinese*.

This so useful Cycle, which in the printed History is a certain Rule to fix Time, the ingenious *Tartar* has disposed in his Table with such Art as renders the Relation of the Years of the Cycle to the Years of the Emperors very sensible ; whence spring great Advantages that are very visible to whoever attentively considers the Table, and penetrates into its Arrangement.

In the Front of the Table appears a Line writ in Capital Letters, and extend s Horizontally from Right to Left : This Line contains, according to the Order of their Succession, the Names of twenty-one Dynasties, or Imperial Families, who have reigned since four Centuries before *Jesus Christ* unto this Time.

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These Names placed exactly on the Lines, where are the Beginnings of the Dynasties to which they belong, are as sure Guides for easily finding them, and under the Direction whereof one comes without Difficulty to the Knowledge of the Emperors of these Imperial Families, as well as the Incidents of their Reigns.

This Cycle is placed in the Middle, in a perpendicular Line or Column, which extends from the Top to the Bottom of the Table, and is divided into sixty little Lodges or square *Area's*, every one of which answers a Year of the Cycle, and contains the Name of the Year it answers. The Angles, or empty Spaces which surround the Name in each of these Lodges, were coloured black, that the whole may the more readily strike the Reader's Eye, and be the more easily distinguished.

On the Right and Left of the Cycle thus placed are ranged twenty other Columns, divided into sixty Lodges each, in the same manner as the Cycle; and consequently equal to the Cycle to which they are parallel.

It is in the Lodges of these Columns parallel to the Cycle, that the Years of the Emperors are disposed in their natural Order for above two thousand Years. They are disposed from Top to Bottom, from the Right to the Left, after the *Chinese* Custom; but to avoid Mistake, I mean the Right and Left to the Person who reads the Table. And it is essential to remark, that the Arrangement is such, that each of these Imperial Years referred to the Column of the Cycle by an horizontal Line which falls at
right

right Angles on this Column, answers the Year of the same Cycle, whose Name it bears in History*.

Pursuant to this Explanation, the first Year of the Prince named *Guei lie wang*, at which begins the Table, whereof that is the Epoque, will be found in the first Column at the right Hand, pretty near the Bottom, under the Author's small Preface; and opposite to the fifty-third Year of the Cycle called (19) *Pin chin*; because in History this first Year of *Guei lie wang* has the two Letters *Ping chin* for its Characteristic.

The Reason why this first Year of *Guei lie wang* is taken for the general Epoque of the whole Table, is, because there is neither Clearness nor Certainty in the History before it: But if, because this first Year of *Guei lie wang* is taken for an Epoque, it were placed opposite to the first Year of the Cycle, it would occasion an Anachronism of fifty-three Years. A capital Point, to which those, who intend to use this Chronological Table, cannot give too much Attention.

In a Word, since History has given this first Year of *Guei lie wang* the Name of *Pin chin*, it is not allowed to give it any other in the Table; and one is obliged to refer it therein to the Year of the Cycle that bears that Name, under the Penalty of being guilty of confounding Time, and puzzling Chronology.

It is in this Arrangement that all the Artifice of this new Table consists. And this Point once well understood,

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derstood,

* The blank Columns at the End are left to put down the future Emperors as they shall succeed.

derstood; is a Key which gives Entrance into all the rest.

The first Year of *Guei lie wang* being placed at the fifty-third Year of the Cycle, the second Year of this Prince will necessarily answer the fifty-fourth of the Cycle, the eighth of the same Prince the sixtieth and last of the same Cycle; and of Consequence the ninth of *Guei lie wang* will be the first of the ensuing Cycle; and so of the others in a continued Series of twenty-one Centuries down to the present Time.

As all the Columns of the Table are parallel to the Cycle, so they are equal to it, and contain sixty Years, as that does. Hence flows an easy Method to know in a Moment the Interval of Time elapsed between any two Years whatsoever of the Table: For it is but multiplying by sixty the Number of entire Columns between the two Years whose Interval is sought, adding thereto what remains in the two Columns on the Right and Left, until you reach the two Years in question. Every one knows that Multiplication by sixty is very easily performed by multiplying by six, and adding a (0) Cypher to the Product.

By this Method a Moment's Attention will make a judicious Reader know that there are 424 Years elapsed since the Epoque of *Guei lie wang* to the Year wherein *Denis le Petit* places the Birth of our Saviour: For this Year has been marked on the *Latin Table*, to be as its Center, and serve the *European Litterati* for a fixed Point, to regulate their Calculations on. Supposing *Petavius's* Doctrine true, this *Dionysian* Æra is one Year before the vulgar Æra, which last should be preferred as being most in Use, if we had
not

not considered that it coincides with the first Year of the Emperor *Ping Ti*. And in regard to the Scantiness of Space, it could not be engraved therein, without omitting the Name of this Emperor, which it was necessary to preserve.

But if on one Hand the Epoque of *Guei lie wang* placed in the fifty-third of the Cycle, and once well comprehended, becomes a Key that opens the Knowledge of the Table, and develops its System; on the other, the Characteristic Names of the sixty Years which compose the Cycle, do by their Connection with the Years of the Emperors determine the precise Time of Incidents. Hence arises Clearness and Certainty in the *Chinese* Chronology; for these Characteristics contribute to the Discovery of Errors, which either the Ignorance and Neglect of Copyists and Printers, or the Want of Attention in Authors, often introduce into Chronology.

For Example: In the Chronological Table of the *Chinese* Monarchy, printed at the End of the Work, whose Title is, *Confucius Sinarum Philosophus*, it is said, that *Chi hoang Ti* *, in the twenty-fourth Year of his Reign, built, or (to speak more accurately) finished the great Wall; and consequently the burning of the Books is placed in the same Emperor's twenty-fifth Year. Now according to History, the great Wall was finished in the Year of the Cycle called (20) *Ting hai*, a Name that can agree only

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* Vide *Monarchiæ sinicæ tabulam chronologicam*, p. 24 & 25. *Chi hoang Ti*, anno imperii 24^o murum celeberrimum 400 & ultra leucarum extruxit contra Tartarorum eruptiones: anno 25^o libros omnes præter medicos & judicarios cremari jussit.

(*Chi should be pronounced like our English She.*)

with the thirty-third Year of this Emperor's Reign. As to the burning of the Books, it is marked in History in the Year (21) *Tou Tse*, which necessarily answers the thirty-fourth Year of this evil Prince.

Thus these Characteristic Names of the Years that compose the Cycle, are as a Touch-stone, that is of wonderful Service for distinguishing Truth from Falshood, and re-establishing Order when disturbed.

This Cycle removed, the Years of Emperors might be very easily confounded, by augmenting or diminishing their Number.

When an Emperor is newly come to the Throne, if the first Year of his Reign be reckoned that, wherein his Predecessor died, it is placing two Years in one; because according to the *Chinese* Custom the Year, wherein an Emperor ends his Reign, is wholly attributed to him, though he died in the Beginning of the first Month; and his Successor is held to reign only from the Beginning of the ensuing Year.

Yet this Custom, though very common, is not so universal, but that some Emperors have derogated from it. The *Tartarian* Emperor *Tchang hoang Ti*, Founder of the Dynasty now reigning, caused the Year, wherein *Hoai Tjong* had murdered himself, to be taken for the first Year of his Reign, which was the seventeenth and last of this last Emperor of the *Mings*.

If, according to Custom, this seventeenth and last Year of *Hoai Tjong* were distinguished from the first of *Tchang hoang Ti*, it would be making two Years of one, which would confound Time.

Resume the Cycle, apply it to the Years of the Emperors, and these Errors will appear of themselves. You will

will see that the Year wherein *Hoai Tsong* died was called (22) *Kia Chin*; that that, wherein *Tchang Joang* began his Reign, was likewise called *Kia Chin*: therefore they are the same Year. If it were made two, the Mistake would be found at first Sight, and should be corrected.

Under the (23) *Yen* those occidental *Tartars*, whose Domination over *China* began in the Year 1280, and ended in 1368, the Emperor *Yen Tsong* died in 1333: *Ning Tsong* his Successor reigned but some few Months, and *Chun Ti*, who succeeded *Ning Tsong*, mounted the Throne towards the End of the same Year. Three Years may be easily made of this one, in order to place the three Princes just named. But whoever makes use of the Cycle need not fear the Mistake. The Deaths of the two first Emperors, and the Accession of the third to the Throne, are three Incidents, which History refers to the Year of the Cycle named (24) *Quei yeou*. And this Characteristic Name is a Link that binds them all together, so that it is no longer possible to separate them.

These Examples suffice: It is easy to comprehend, that if during Interregnums or Anarchies, the Time were lengthened or abridged, or if it were confounded during Civil Wars carried on between two clashing Families disputing the Sovereign Power, the Application of the Cycle would set all right.

The Names which mark the Years of the Cycle are then a certain Rule to redress the Errors of unskilful Chronologers. They resemble a Torch which gives Light in a dark or difficult Path. The Learned, who will know to set a just Value on these Characteristics, will.

will be pleased with them, and will perhaps prefer them for Use to the Consular Reckonings, wherein are found so many discouraging Interruptions. And if Medals have somewhat more enticing and splendid in them, there is a certain Simplicity always uniform in the Continuation of the Years of the Cycle necessarily followed, which leads the Mind to Truth by an easy Road, without much Ornament, Expence or Enquiry after Monuments.

Another Property of this new Table, no less remarkable or useful than the foregoing is, that this Table lays before the Eye all the Names of the particular Epoques assumed by the Emperors of *China* for near two thousand Years. For *Han uou Ti*, the first who took this Sort of Epoque, began his Reign one hundred and forty Years before *Jesus Christ*.

No body, to the best of our Knowledge, has given *Europe* a sufficient Account of the Nature of these Epoques, though they are very well worth explaining. The Emperors of *China* have a particular Custom, little known in *Europe*, which, if Care be not taken, would infallibly spread Darkness and Confusion over Chronology and History. It is not allowed to pronounce the proper Name of any Emperor during his Life, which is looked on in some Measure as inflexible. This Respect continues even after their Deaths; for then it is not by their proper Names they are mentioned, but are consecrated (if we may use the Term) by a Surname, which is a Sort of Character of Canonization. And under this Title are they received into the Burying-place of their Ancestors, and afterwards ranked in History. But in their Life-time, to supply
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the Name that dare not be pronounced, they themselves, in Imitation of *Hon uou Ti* already mentioned, choose and determine a Term that serves for an Epoque to the Incidents of their Reign. This Term we call Epoque, because it is from it the Years of Emperors are reckoned, and to it is referred every thing that falls out during these Years. Examples will make these Things easy to comprehend. The famous Emperor who died *December 20, 1722*, after a Reign of sixty-one Years, had the Letter (25) *Hien* for his proper Name. During his Reign, this Letter was not to be put into any publick Memorial, Book or Writing. The Letter (23) *Tuen* was substituted in its Room, because it would be a kind of Prophanation to employ for common Use the Name of a Prince, who stiled himself (25) *Son of Heaven*.

After his Death his fourth Son, who succeeded him gave him for Title of Canonization, the glorious Surname of (27) *Ching Tson gin boang Ti*; as much as to *Yay, the holy Ancestor, the august, good and merciful Emperor* *. It is under this Surname that he has been interred among his Ancestors, and it is under the same that History will make mention of him for the future.

Upon his ascending the Throne after a Father who had conquered *China*, he assumed for the Epoque of his Years the two Letters *Kang hi*, the Sense whereof is *Solid Peace*, or *lasting and glorious Tranquillity*. Thus because in the † thirty-eighth Year of his Reign,

* This Character Gin, which I have translated gracious and merciful, signifies Charity: it also expresses sometimes the Conjunction of all Virtues: and it may bear that Sense here.

The Character Hoang (27 *) when analysed, is found to be composed of *Tse*, which signifies of himself, and *Wang*, which translated is Reigning.

† In the thirty-fifth.

Reign he conquered by his Generals a Prince of *Tartary* named *Kaldan*, this Victory is said to be gained the thirty-eighth Year of *Kang hi*, or of *the lifting and glorious Tranquillity*.

The Letters (28) *Yn Tchih* compose the Name of his fourth Son, who now reigns; wherefore the Use of these Letters is and will be prohibited until a new Government. As to the Title of Canonization, by which this Prince is to be recorded in History, it will not be given him till after his Death. But upon his Accession to the Crown, as he had a great Number of Brothers and Nephews, he took for Epoque of his Years the two Letters (29) *Yong Tching*, which signify *Direct Concord*; to give to understand, that if his Brothers and Nephews pay him the Respect and Submission they owe him, he would treat them with Kindness.

The Empress his Mother died some few Months after he began his Reign; so the Death of this Princess will be marked in History in the first Year of *Yong Tching*, or of the *Direct Concord*. Thus will all other Incidents be fixed by the Years of the *Direct Concord* in which they will happen.

It is plain from these Examples, that the Names of Emperors, and the Names of their Epoques are essentially different, and that those of the Epoques comprehend very instructive Meanings, the understanding which must be of great Service to the clearing up of History.

But there is great Danger lest the Name of an Epoque be made the Name of an Emperor, which would double the Number of Emperors, supposing
even

even that each of them had taken but one Epoque during his Reign.

No *European* Writer, that we know, has faithfully given them all: But this Table presents us with an exact and entire Series of them. And yet it is a thing much to be wished for, to have a faithful Explanation of them; a Work which would engage one in a Review of the whole History, but will be undertaken nevertheless, if we find room to hope, that it will not be disagreeable to the Learned.

The Inconveniency is, that a great Number of Emperors have often changed these Names of Epoques. This Inconveniency is not found in the Dynasty now reigning; but in the more ancient it is a very common Disorder. *Han you Ti*, the first that introduced the Use of Epoques, assumed, during his fifty-four Years Reign, to the Number of eleven very different Epoques. Several others have followed his Example, which cannot but cause a great deal of Confusion in History, if one happened to imagine, as it is natural enough to do, that these Names of Epoques are the Names of so many Emperors.

It was of Importance to clear up these Things thoroughly; this the Table does: and to avoid Mistake, Care has been taken to have the Emperor's Names or Titles engraved in large Characters, and those of the Epoques in small Letters. Moreover, when an Emperor, not content with one Epoque, has taken several, Notice is given of it by a Star placed on one Side of the first.

In short, to leave nothing conjectural, as often as a Reader considering this Table, shall find two separate

Ranks of Figures opposite to one another in a Series of several Lodges, denoting different Numbers, he is to remember, that these Figures mark the Years of Emperors of two Families, which dispute the Empire, one of which being soon to perish, will give room to the other to ascend the Throne. The Column found under the Title *San Koue*, that is to say, *the three Kingdoms*, is an Example hereof. This Title of three Kingdoms denotes the Time when *China* was divided into three different Parts; and the Column, on the Top of which is found that Title, in the Order of the Dynasties is the twelfth, reckoning from the first at the Reader's right Hand inclusively. We see in the forty-third Lodge that the first Year of the Epoque *Tai ho* assumed by the Emperor *Ming Ti*, of the Family called *Guei*, answers to the fifth Year of the Epoque *Kien hing* assumed by *Heou Tchu*, Emperor of the *Han's*: the second Year of the Epoque *Tai ho* answers to the sixth of the Epoque *Kien hing*, and so of the rest that follow. The Reason is, that the Empire was at that Time torn in Pieces by bloody Wars: The *Guei's* were getting the upper Hand, and the *Han's* very near their Ruin.

As to a great Number of Lodges that have but one or two Figures, without any Account of History, they are unpleasing Blanks, which however the *Chinese* matter not, satisfied to have an exact Series of their Emperors Years in these Lodges. But such Blanks may be filled by inserting some considerable Incidents of History, as some few have already been in the *Latin* Edition, *viz.* the building of the great Wall, the burning of the Books, the *Christian* Era, the

the Introduction of the *Christian* Religion into *China*, the Appearance of a Star seen in the Heavens upwards of seventy Days *, the true Year in which our Saviour was born, &c. If this Addition please the Learned, it will be no difficult Matter to add several other Incidents unknown in *Europe*.

This is what occurs to be said for perfectly understanding the new Chronological Table of the *Chinese* History. This Exposition will be of Service to such as think the *Latin* Instructions at the Head of the Table insufficient; not that this Table has of itself ought that can puzzle a Person ever so little accustomed to this Kind of Study. The *Chinese* Youth play with it, and see the Matter in question at first Sight: But it is an Object hitherto unseen in *Europe*; and that is sufficient to startle certain Readers, who, though Men of Sense, frequently seek Mysteries, where there are none; and then Perspicuity itself becomes Obscurity. For Persons of this Character the best Way would be to consider the Table for some Moments with one, who has already comprehended its Use. A little Instruction by Word of Mouth is better than a thousand Commentaries: The Eye does a great deal, but the Ear is much more efficacious for infusing Knowledge into our Minds without Labour. When these two principal Senses are united, and applied in Concert, Difficulties which looked frightful, are seen to vanish.

To conclude, it is Use only can make one sufficiently sensible of all the Advantages of this Table.

L I I 2

Those

* The Chinese say of this Star, that it was a Sign of Renewal in the World.

Those who have no Inclination to know what has passed in *China*, who read not its History nor Accounts, who study not its Religion, Arts, Sciences, Government, nor Policy, have no Need of this Table; but whoever applies himself to the Study of the different Articles just mentioned, may be assured that he will draw such Helps hence as Experience alone can enable him to set a just Value on. For at first Glance of the Eye one will see therein the Beginning and the End of all the Reigns, the Duration of the Dynasties, the Succession of the *Chinese* Monarchy; and that one will therein discover, as in a faithful Looking-Glass, the Faults of Chronology dispersed in several Authors: But the principal Advantage is, that this Table, conformably with the most valued History, fixes the true Epoque of the *Chinese* Empire to four Centuries or thereabouts before the Birth of our Saviour. By the true Epoque of the Empire understand not the Beginnings of the Nation, which it is credible (as we have remarked before) remount to the next Ages after the Deluge; but the Beginning of the Monarchy, which is the Time, when the Incidents that happened in this Nation, appearing grounded on certain Proofs, deserve the Credit of learned Men. This important Point once cleared up, ought to put an End to the Disputes of the Learned on the fabulous Antiquity of *China*. Excellent Wits, capable of greater Things, will henceforth disdain to employ their Lucubrations in such frivolous Scrutinies.

VI. *An Account of Mr. Mark Catesby's Essay towards the Natural History of Carolina and the Bahama Islands, with some Extracts out of the first three Sets. By Dr. Mortimer, R. S. Secr.*

OUR Author proposes in this Work to give the Figures of the Birds, Beasts, Fishes, Serpents, Insects and Plants, the greatest Part whereof have never been described by any Author, or no good Figures given of them. He gives the Description of them in *English* and *French*, with Observations of the Air, Soil and Water; and an Account of the Agriculture, Grain, Pulse, Roots, and other Productions of the Country, with a Map of the same. The Author was near four Years in these Parts, where he designed every thing from Nature in their proper Colours: in order to make the coloured Prints almost equal to his Original Paintings, he engraves and colours them with his own Hand. In this short Account I shall recite the Names of the several Animals and Plants, and as a Specimen of what is described more at large just hint some few of the remarkable Things which occur in the Descriptions of them.

1. He begins with the *Aquila capite albo*, the bald Eagle. This Bird lives on Fish.

2. *Accipiter Piscatorius*, the Fishing Hawk. This also lives on Fish, which it takes by plunging into the Water. The bald Eagle commonly attends him, and

and when he sees that an Hawk hath got a Fish, he compels him to let it fall, and is so very swift as seldom to fail catching it before it comes to the Water.

3. *Accipiter Plumbarius*, the Pigeon Hawk, somewhat resembling ours, only it hath four white Lines cross its Tail.

4. *Accipiter Cauda furcata*, the. Swallow-tail Hawk.

5. *Accipiter minor*, the little Hawk.

6. *Buteo, Specie Gallo-Pavonis: seu Vultur Galinae Africanae facie* Hist. Jam. p. 294. Vol. II. The Turkey Buzzard. This Bird feeds on Carrion, and is wonderfully sagacious in smelling a Carcass at a very great Distance.

7. *Noctua Aurita minor*, the little Owl.

8. *Caprimulgus*, the Goat-sucker, which feeds on Insects, with a *Grillo-talpa*.

9. *Cuculus Carolinensis* the Cuckow; with the *Cassanea pumila Virginiana, fructu racemoso parvo, in singulis capsulis echinatis, unico.* D. Banister. The Chinkapin.

10. *Psittacus Paradisi ex Cuba*, the Parrot of Paradise from Cuba; with the *Frutex Lauri folio pendulo, fructu triccoco, semine nigro splendente*, the Red-wood.

11. *Psittacus Carol.* the Carolina Parrot, with the American Cypress.

12. *Monedula purpurea*, the purple Jackdaw.

13. *Sturnus niger, alis superne rubentibus*, the Red-winged Starling, with the *Myrtus Brabantica similis*,

similis, Carolinensis humilior, foliis latioribus & magis serratis, the broad-leaved Candle-berry Myrtle.

14. *Hortulanus Carol.* the Carolina Ortulan, with Rice on which it feeds.

15. *Pica Glandaria cœrulea cristata*, the blue Jay, with the *Smilax lævis Lauri folio baccis nigris*, the Bay-leaved Smilax.

16. *Picus maximus rostro albo*, the large white Bill'd Wood-pecker, with the *Quercus, an potius Ilex? Marilandica, folio longo angusto salicis*, the Willow Oak. *Raj Hist.*

17. *Picus niger maximus capite rubro*, the large Red-crested Wood-pecker, with the *Quercus semper vivens foliis oblongis non sinuatis*. *D. Banister*, the live Oak.

18. *Picus major alis aureis*, the Golden-winged Woodpecker; with the *Quercus castaneæ foliis, proceræ arbor Virginiana*. *Pluk. Alma.* the Chesnut Oak.

19. *Picus ventre rubro*, the Red-bellied Woodpecker.

Picus medius quasi villosus, the hairy Woodpecker.

Quercus (forte) Marilandica, folio trifido ad Sassafras accedente. *Raj Hist.* the Black Oak.

20. *Picus capite toto rubro*, the Red-headed Woodpecker. *Quercus folio non serrato in summitate quasi triangulo*. the Water Oak.

Syringa baccifera, Myrti subrotundis foliis, floribus albis gemellis ex Provincia Floridana. *Pluk. Amalth.* 198. *Tab.* 444.

21. *Picus varius minor, ventre luteo*, the yellow Bellied Wood-pecker.

Picus varius minimus, the small spotted Woodpecker.

Quercus

Quercus alba Virginiana, Parkinson. the White Oak.
Quercus Carolinensis virentibus venis muricata,
 the White Oak with pointed Notches.

22. *Sitta capite nigro*, the Nut-hatch.

Sitta capite fusco, the small Nut-hatch.

Quercus humilior salicis folio brevior, the Highland Willow Oak.

23. *Palumbus Migratorius*, the Pigeon of Passage.
 These come in such incredible Numbers, that in some Places where they roost, which they do sometimes upon one anothers Backs, they have broke down Branches of Oak Trees with their Weight, and leave their Dung some Inches thick on the Ground under them. They are supposed to come far North of the River St. Lawrence.

Quercus Esculi divisura foliis amplioribus aculeatis. Pluk. Phytograph. Tab. LIV. the Red Oak.

24. *Turtur Carolinensis*, the Turtle of Carolina.
 They feed much on the Berries of the *Blitum Virgin.* which are Poison, yet these Birds are reckoned good Meat.

Anapodophyllum Canadense Morini, vid. Turnesf. inst. p. 239 the May-Apple.

25. *Columba capite albo*. Hist. Jamaic. p. 303. Tab. 261. Vol. II. the white crowned Pigeon.

Frutex cotini fere folio crasso, in summitate deliquium patiente, fructu ovali cœruleo, [vel rubro] ossiculum angulosum continente, the Cocoa-Plumb.

26. *Turtur minimus Guttatus*, the Ground-Dove.

Zanthoxylum spinosum, Lentisci longioribus foliis, Euonimi fructu capsulari ex Insula Jamaicensi, D. Banister Phytogr. the Pellitory or Tooth-ach

ach Tree. Its Bark is hot and aromatic, and therefore used for the Tooth-ach.

27. *Turdus minor, cinereo-albus non maculatus*, *Hist. Fam. p. 306. Tab. 256. Fig. 3.* the Mock-Bird. They mock or imitate the Notes of all Birds, from the humming Bird to the Eagle.

Cornus mas Virginiana, flosculis in corymbo digestis, perianthio tetrapetalo albo, radiatim cinctis *Pluk. Almag. 120.* the Dogwood Tree.

28. *Turdus Ruffus*, the Fox-coloured Thrush.

Cerasi similis arbuscula Mariana, pedi folio, flore albo parvo racemoso. *Pluk. Mantiss. 43. Tab. cccxxxix.* the clustered black Cherry.

29. *Turdus pilaris, Migratorius*, the Fieldfare of Carolina.

Aristolochia Pifolochia, seu Serpentaria Virg. caule nodoso. *Pluk. Almag. p. 50. Tab. 148.* the Snake-root of Virginia.

30. *Turdus visciivorus plumbeus*, the Red-legged Thrush.

Terebinthus major Betula cortice, fructu triangulari, *Hist. Fam. Vol. II. p. 89. Tab. 199.* the Gum Elemi Tree.

31. *Turdus minimus*, the little Thrush.

Agrifolium Carolinense, foliis dentatis, baccis rubris, the Daboon Holly.

32. *Alauda gutture flavo*, the Lark.

Gramen Myloicophoron Oxyphyllon Carolinianum. *Pluk. Almag. p. 137. Tab. 32.* the Sea-side Oat.

33. *Alauda magna*, the large Lark.

Ornithogalum luteum parvum foliis gramineis glabris, the little yellow Star-Flower.

34. *Passer niger, oculis rubris*, the Towhe Bird.

Passer fusca, the Cow-pen Bird.

Populus nigra, folio maximo, gemmis Balsamum odoratissimum fundentibus, the black Poplar of Carolina.

35. *Passerculus*, the little Sparrow.

Convolvulus Carolinensis, angusto sagittato folio, flore amplissimo purpureo, radice crassa, the purple Bindweed of Carolina. It is reported that the Indians dawb themselves over with the Juice of this Plant, and then venture to handle Rattle Snakes without any Harm.

36. *Passer nivalis*, the Snow Bird.

Orobanche Virg. flore pentapetalo cernuo Pluk. Almag. p. 273. Tab. cclx. Fig 7. Broom Rape.

37. *Passerculus bicolor Bahamensis*, the Bahama Sparrow.

Bignonia arbor pentaphylla, flore rosco majore, siliquis planis Plum Cat.

38 *Cocothraustes rubra*, the red Bird, or Virginia Nightingal, called in French, *Le Cardinal*.

Nux Juglans alba Virg. Park. Theatr. 1414. the Hicory Tree.

Nux Juglans Carolinensis, fructu minimo, putamine levi, the Piñ-nut.

39. *Cocothraustes calurea*, the blue Gros-Beak.

Magnolia Lauri folio, subtus albicante, the sweet flowering Bay.

40. *Cocothraustes purpurea*, the purple Gros-Beak.

Toxicodendron, foliis alatis, fructu purpureo, Pyri-formi sparsis, the Poison Wood. This Tree distills a Liquid, black like Ink, which the Inhabitants say is Poison.

41. *Fringilla purpurea*, the purple Finch.

Arbor in aqua nascent, foliis latis acuminatis & non dentatis, fructu Eleagni minore, the Tupelo Tree.

42. *Fringilla Bahamensis*, the Bahama Finch.

Arbor, Guajaci latiore folio, Bignonie flore caruleo, fructu duro in duas partes disiliente, seminibus alatis imbricatis positis, the broad-leaved *Guaicum* with blue Flowers.

43. *Carduelis Americanus*, the American Goldfinch.

Acacia, Abrue foliis, triacanthos, capsula ovali unicum semen claudente.

44. *Fringilla tricolor*, the painted Finch. This is a most beautiful Bird; its Head and Neck are blue; its Back green, and the Belly red: The Hen is plain brown like a Sparrow, and so are the Cocks too, when hatched; and it is several Years before they attain their Colours in Perfection. The *Spaniards* call it *Mariposa pintada*, or the painted Butterfly.

45. *Linaria cærulea*, the blue Linnet.

Solanum triphyllon flore hexapetalo carneo.

46. *Garrulus Carolinensis*, the Chatterer.

Frutex corni foliis conjugatis; floribus instar Anemonæ Stellatæ, petalis crassis, rigidis, colore sordide rubente; cortice aromatico. The Bark is as odoriferous as Cinnamon.

47. *Rubicula Americana cærulea*, the blue Bird. This Bird hath a red Breast (and therefore may be called the Robin Red-breast of *America*.)

Smilax non spinosa humilis, folio Aristolochia, baccis rubris.

48. *Icterus ex aureo nigroque varius*, the Baltimore Bird. It hath its Name from being of the same Colour with Lord Baltimore's Coat of Arms, which are yellow and black (Topaz and Diamond.)

Arbor Tulipifera Virg. tripartito aceris folio, mediâ laciniâ velut abscissâ. Pluk. Phytogr. Tab. 117 & 248, the Tulip Tree, so called, because its Flowers somewhat resemble a Tulip.

49. *Icterus minor*, the Bastard Baltimore Bird.

Bignonia Urucu foliis; flore sordide albo, intus maculis purpureis & luteis asperso; siliquâ longissimâ & angustissimâ, the Catalpa Tree.

50. *Oenantha Americana pectore luteo*, the Yellow-breasted Chat. This Bird I never saw in the inhabited Parts: It flies with the Legs extended behind it (like an Heron.)

Solanum triphyllon; flore hexapetalo, tribus petalis purpureis erectis, cæteris viridibus reflexis.

51. *Hirundo purpurea*, the purple Martin.

Smilax (forte) lenis, folio anguloso hederaceo.

52. *Muscicapa cristata, ventre luteo*, the crested Fly-catcher.

Smilax, Bryonia nigræ foliis, caule spinoso, baccis nigris. The Inhabitants of Carolina make a Decoction of the Roots of this Plant, which they esteem a great Cleanser of the Blood; and the tender Shoots in the Spring they boil and eat like Asparagus. They call it there China-Root.

53. *Muscicapa nigræscens*, the Black-cap Fly-catcher.

" *Gelsimum, sive Jasminum luteum odoratum* Virg. *scandens, semper virens* Park. *Theatr.* p. 1465. Though Parkinson calls it *semper virens*, I have always seen it lose its Leaves in Winter.

54. *Muscicapa fusca*, the little brown Fly-catcher.

Muscicapa oculis rubris, the red Eyed Fly-catcher.

Arbor lauri folio; floribus ex foliorum alis pentapetalis, pluribus staminibus donatis.

55. *Muscicapa coronâ rubrâ*, the Tyrant. The Courage of this little Bird is singular; he puts to Flight all Birds, both great and small, that come near his Station: He attacks even the Eagle, by fixing on his Back, and so persecutes him till he lights on some Tree, from whence the Eagle dares not to stir till the little Tyrant thinks fit to leave him. When their Young are flown, they are as peaceable as other Birds.

Cornus mas odorata, folio trifido margine plano; Sassafras dicta. Pluk. *Almag.* In *Virginia* they use a strong Decoction of this Root sometimes with Success in Intermittent Fevers.

56. *Muscicapa rubra*, the Summer red Bird.

Platanus occidentalis, the Western Plane Tree.

57. *Parus cristatus*, the crested Tit-mouse.

Cistus Virginiana, flore & odore Periclymeni D. Banister, the upright Honeysuckle.

58 *Parus uropygeo luteo*, the yellow Rump.

Helleborine, Lilii folio caulem ambiente; flore unico hexapetalo, tribus petalis longis angustis obscure purpureis, cæteris brevioribus roseis, the Lily-leaved Hellebore.

Apocynum scandens, folio cordato, flore albo.
Dog's-Bane.

59. *Parus Bahamensis*, the *Babama* Titmouse. —

Arbor, Jasmini floribus albis; foliis Cenchramideæ, fructu Ovali, seminibus parvis nigris mucilagine involutis, the seven Years Apple. He knows not the Reason of the Name, because the Fruit ripens in seven or eight Months Time.

60. *Parus cucullo nigro*, the hooded Titmouse.

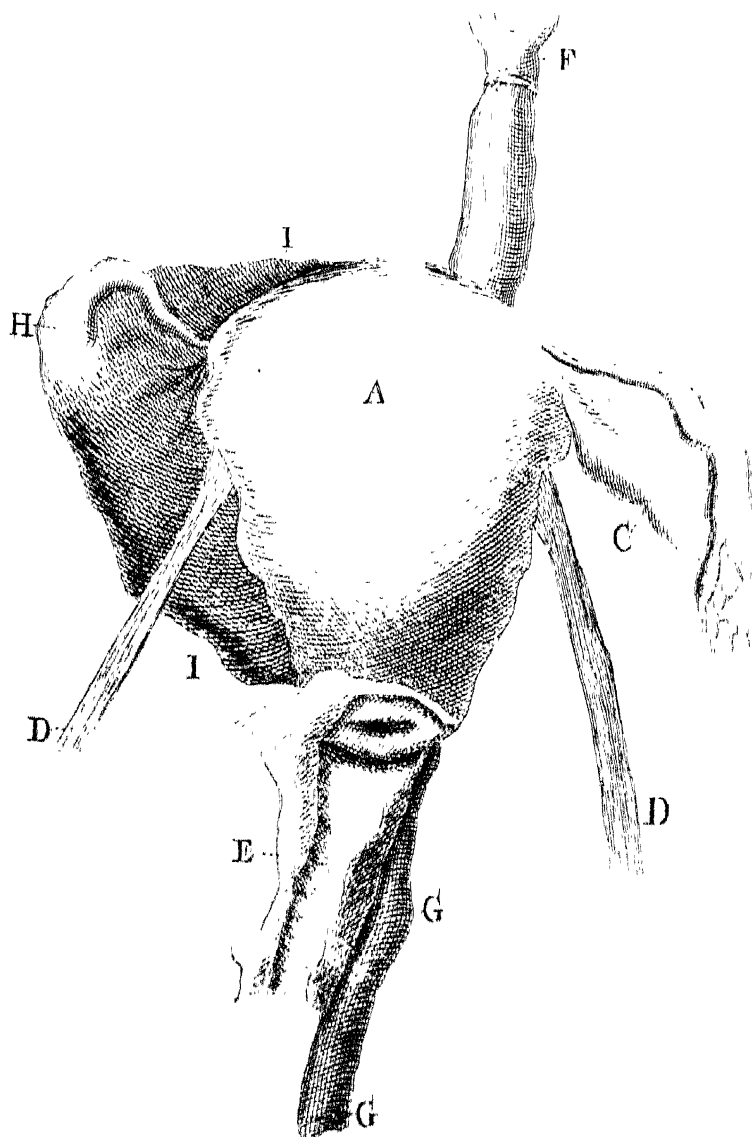
Arbor in Aqua nascens, foliis latis acuminatis & dentatis, fructu Eleagni majore, the Water Tupelo.

ERRATA.

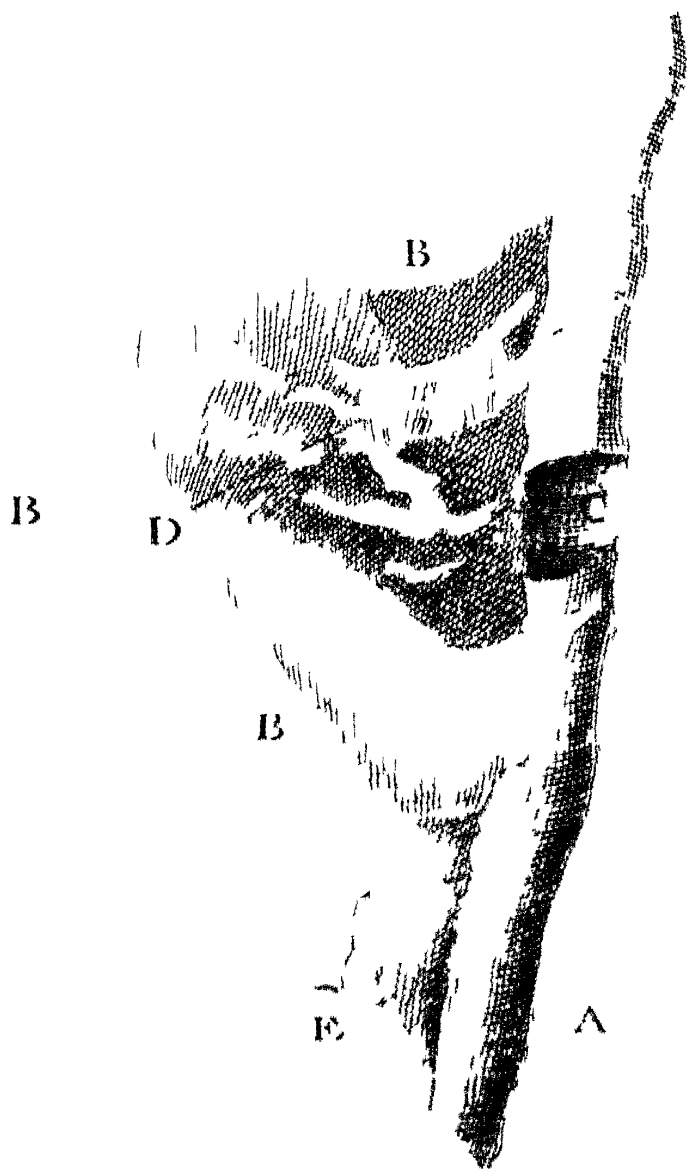
PAG. 378. l. 5. for *villoso* read *hirsuto*. Ibid. l. 7. after *glabro* add *altiore*. P. 388. l. 6. after *Figure A* add *Tab. I. Fig. 2.* P. 395. l. 15. add *Vid. Tab. I. Fig. 3.* P. 402. at the Bottom, read 1722. P. 403. l. 25. after *twelfth Century* add a Mark, which must be referred to the Note at the Bottom of the Page *Sæculo 13^o*, these Notes containing the different Readings of the two Accounts, and the Explanation at the Head of the printed Table. P. 411. l. 9. after *Characters* add *which*. lb. l. 6 from the Bottom, for *and extends*, read *which extends*. P. 415. l. 7. after 53d add *Year*.

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THE Chronological Tables of the *Chinese* History, in *Latin*, are to be sold by *W. Innys* at the West End of *St. Paul's*, *N. Prevost* over against *Southampton-street* in the *Strand*, and *Mr. Hanksbee*, at the House of the *Royal Society* in *Crane-Court, Fleet-street*.



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PHILOSOPHICAL TRANSACTIONS.

FOR THE

Months of *November* and *December*, 1730.

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- II. *An Extract of a Letter from Mr. William Stevenson to Benj. Hoadly, M. D. F. R. S. Containing an Account of an Observation of an Eclipse of the Moon, on July 29, 1729, made in Barbados by Mr. Stevenson's Brother.*
- III. *The Anatomical Preparation of Vegetables, by Albertus Seba, F. R. S. Communicated to the Royal Society by Sir Hans Sloane, Bart. Pr. R. S. and Col. Med. Lond. Translated from the German, by Mr. Zolman, F. R. S.*
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V. *The Postscript of a Letter from George Martin, M. D. to William Græme, M. D. F. R. S. giving an Account of the Operation of Bronchotomy, as it was performed at St. Andrews.*

VI. *Observationes Cœlestes multifariæ, Annis 1728 & 1729. Pekini in Sinis habitæ, & ad Rev. P. Johannem Baptistam Carbone, Soc. Jæs. transmissæ; ex ejusdem Cl. Viri Epistola ad Jacobum de Castro Sarmento; M. D. Col. Med. Lond. Lic. & R. S. S.*

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I. *An Account of the præternatural Delivery of a ~~Fœtus at the~~ Anus; communicated by Mr. Nourse, one of the Assistant Surgeons to St. Bartholomew's-Hospital; Demonstrator of Anatomy at Surgeons-Hall, and F. R. S.*

TH E kind Invitation I had from Mr. *Giffard* the Surgeon, to assist at the Opening of a Patient of his, gives me an Opportunity to lay before this Society, a Case as extraordinary, and I believe very like what *Monf. Littre* has given us in the *Memoirs of the Royal Academy of Sciences at Paris, Ann. 1702; (viz.)* where a *Fœtus* had no other *Nidus* than the *Ovary*; and was brought forth through the *Rectum*. The Symptoms previous to this præternatural Birth, the forementioned Gentleman has very faithfully drawn up; be pleased therefore to take them in his own Words.

‘ I was sent for about the middle of *August* last, to
 ‘ a Woman who then judged herself to be between
 ‘ three and four Months gone with Child; she had all
 ‘ the Symptoms preceding a Miscarriage, and upon
 ‘ touching, I found the *Os Tincæ* somewhat dilated and
 ‘ spread, from whence I concluded a Miscarriage would
 ‘ ensue, and therefore ordered what I thought proper
 ‘ to promote it; but I was sometime after informed by
 ‘ her Husband, that although she before believed that
 ‘ she had miscarried, yet that she now thought herself
 ‘ Quick; as feeling somewhat to move within her Belly,
 ‘ agreeable to what she had perceived after former
 ‘ Quicknings. Thus it passed on for about six or seven
 N n n ‘ Weeks;

Weeks; in which Time she grew much bigger, and the Motion more perceptible; so that there remained no Doubt of her being with Child. About the third of October she was seized with violent Pains in her Belly and Back; which daily increasing, her Sister, by her Desire, came to me on the sixth, when I went to her, and found her labouring under very great Pains, and other Complaints like those preceding a Miscarriage or Delivery: But to be better satisfied, and to strengthen my Opinion, I passed up two Fingers into the *Vagina*, to examine by the Touch, whether the *Os Tincæ* began to open and spread. I there felt a large and unusual Fulness and Tension, which I then judged to be the Body of the *Uterus* sunk low into the *Vagina*, and much distending it, and extending backwards, and pressing against the *Rectum*, so that the Excrements could not readily pass, neither could she, from its Pressure upon the Neck of the Bladder, freely make Water. I could not find the *Os Tincæ*, although I very carefully examined all about with the Ends of my Fingers; wherefore I then judged that the *Fundus Uteri* must have receded from its natural Position, and be bent backwards towards the *Rectum*: In which Opinion I was the more strengthened from the Fulness I before observed, stretching backwards; and therefore concluded that the *Os Tincæ* must be very forward: Wherefore I endeavoured to pass my Fingers between the *Os Pubis* and the Fulness which pressed against the upper Edge of the said Bone. This with some Difficulty I effected, and at length about two or three Inches above the said Bone, I felt the *Os Tincæ* with the Ends of my Fingers. The Cause of this Situation will

more

‘ more clearly appear in the Pursuit of this Account.
 ‘ I ordered her anodyne and quieting Medicines to re-
 ‘ lieve her Pain, which she was obliged to repeat at
 ‘ least every twelve Hours, with proper Cordials to sup-
 ‘ port Nature; and sometimes Clysters. Thus matters
 ‘ continued to the twentieth of the said Month, only
 ‘ that for some Days before, a Water tinged with Blood
 ‘ came away, as she imagined, through the *Anus*, and
 ‘ which she believed proceeded from the Piles, with
 ‘ which she was sometimes troubled.

‘ On the twentieth, her Husband came to me about
 ‘ six of the Clock in the Morning, telling me that the
 ‘ Midwife had brought away a *Fœtus*, but could not
 ‘ compleat her Business; whereupon I immediately
 ‘ went to the Midwife, who upon my coming told me
 ‘ that a *Fœtus* was protruded through the *Anus*; and
 ‘ to confirm it, desired me to examine, which I did im-
 ‘ mediately, and found the *Funis Umbilicalis* hanging
 ‘ out about two or three Inches beyond the *Anus*,
 ‘ and passing up through the same: I therefore passed my
 ‘ two fore Fingers by the String into the *Anus*; when
 ‘ I found about three Inches up, an Opening, as I then
 ‘ judged, into the *Uterus*, wide enough to admit the
 ‘ Ends of three or four Fingers, and the *Funis Um-*
 ‘ *bilicalis* passing into it; from hence I was assured that
 ‘ the *Fœtus* came out that Way. I endeavoured, with
 ‘ my Fingers passed into the Opening, to bring away
 ‘ the *Placenta*; but as it was very rotten, it tore a-
 ‘ way between my Fingers, so that I was forced to
 ‘ bring it in small Pieces, and was at last obliged to
 ‘ leave a large Part of it. The *Septum* or Partition
 ‘ between the *Anus* and *Vagina* was entirely whole,
 ‘ and no Perforation through it. From these Appear-

ances I then concluded that a Mortification must have begun in the *Uterus*, and so from its Contiguity be communicated to the *Rectum*; so that Nature endeavouring to expel what was contained, and forcing it against this Part already mortified, and consequently ready to give way and separate upon any Pressure made against it, produced this Opening, and the Protrusion of the *Fœtus* through it into the *Rectum*, and so on through the *Anus*.

There was a large Discharge of grumous Blood and other Substances through the *Anus*, which continued coming away until the twenty-sixth of the aforesaid Month, when the Woman died about three of the Clock in the Afternoon.

I should have observed that there was a Fulness and Hardness very perceptible, to be felt outwardly in the fore-part of the Belly, some distance below the Navel, from the Time that the *Fœtus* came away to her Death; which upon opening the Body, I was well assured, was the *Uterus* forced upwards and forwards by a *Sacculus*, which being large and distended filled up the *Pelvis*; and by its Bulk pressed the *Uterus* forwards. The *Fœtus* was perfect in all its Parts; but much wasted and shrunk from its being some time dead; and consequently putrified.

This we thought necessary to premise an Examination of the Parts (which I have here brought) whose Appearances upon Dissection, were as follow.

The *Vagina*, *Uterus*, *Ligamenta Rotunda*, left *Ovary*, *Fallopian Tube*, and *Ligamentum Latum* on that side, together with the Hypogastrick, and Spermatick Vessels on the same Side, were in a natural State. The *Fallopian Tube* on the right Side, we traced

traced from the *Fundus Uteri* almost to the *Morsus Diaboli*; where it was confusedly united with, and opened into the *Sacculus* hereafter to be described. The *Ovary* on this side with the *Ligamentum Latum*, was dilated into a large *Sacculus* of an irregular Form, extending itself behind the *Uterus* (to the posterior Paries of which it adhered) and passing on towards the left, was connected to that Part of the *Colon* that terminates in the *Rectum*, and the *Rectum*. In this *Sacculus* we found great part of the *Placenta*, and the Remains of lacerated Membranes, besides the Aperture of the *Fallopian Tube* mentioned before, and another about four Inches in Diameter into the Middle of the *Rectum*: That part of the *Ureter* on the right Side which lies between the *Ovary* and the *Kidney* was dilated, and so was that part of the *Rectum* between the Aperture into it, and the End of the *Colon*; both which were caused from the Contents of these Canals being obstructed in their Passage.

FIG. I.

Shews the *Uterus*, with the *Sacculus* behind it, part of the *Colon* and the *Rectum*; the *Fallopian Tubes*, *Ovary* on the left Side; *Ligamenta Rotunda*; and the *Vagina* laid open to the *Os Tincæ*.

A The *Uterus*.

B The *Fallopian Tube* on the left Side.

C The *Ovary* on the same Side.

D The *Ligamenta Rotunda*

E The *Vagina* laid open.

F That part of the *Colon* that terminates in the *Rectum*.

G The *Rectum* continued to the *Anus* under the *Vagina*.

H The

H The *Fallopian Tube* on the right Side, whose Extremity opens into the *Sacculus* formed from the *Ovary*.

I The *Sacculus* extending itself behind the *Uterus*; wherein we found the *Placenta* and several lacerated Membranes; and from whence there was a large Opening into the *Rectum*.

FIG. II.

Shews the Inside of the *Sacculus* and its Aperture into the *Rectum*.

A The Intestine.

B The *Sacculus* adhering to it.

C The Opening from the *Sacculus* into the *Rectum*.

D The Membranes found within the *Sacculus*.

E The *Vagina* turned to the Right.

II. *An Extract of a Letter from Mr. William Stevenson to Benj. Hoadly, M. D. F. R. S. Containing an Account of an Observation of an Eclipse of the Moon, on July 29, 1729, made in Barbados by Mr. Stevenson's Brother.*

‘ **H** E took care to regulate a very good Clock, and brought it to true Time about 14 Days before the Eclipse. On the Day it happened, he saw the Sun set, and found the Clock right, according to the mean Time, Refraction allowed. At the Beginning of the Eclipse, the Moon was clouded. At 7 H. 18 M. (in the Evening) apparent Time, he saw the Moon 2 Digits Eclipsed, about 30 Degr.

' to the left of its Nadir-Point. At 8 H. 11 M. the
 ' totally immersed into the Earth's Shadow, about
 ' 30 Degr. to the right Hand of her Vertical Point.
 ' 21 9 H. 51 M. she emerged out of the Shadow,
 ' 79 or 80 Degr. to the left of her Nadir-Point. At
 ' 10 H. 50 M. the Eclipse ended, 88 Degr. to the
 ' right of her Vertical Point. In this, and all the
 ' other Observations he made of both Solar and Lunar
 ' Eclipses, during several Years he has been in *Barba-*
 ' *dos*, he found that they always happened 10 Mi-
 ' nutes sooner than his Computation. Whence he con-
 ' cludes, that that Island lies 2 Degr. and a Half
 ' more Westerly than is generally supposed.'

III. *The Anatomical Preparation of Vegetables, by*
Albertus Seba, F. R. S. Communicated to the
Royal Society by Sir Hans Sloane, Bart. Pr.
R. S. and Col. Med. Lond. Translated from
the German, by Mr. Zolman, F. R. S.

TAKE Leaves of Trees or other Vegetables, that
 are somewhat substantial and tough, and have
 woody Fibres; as for Instance, Leaves of Orange
 Trees, of Lemon, Jasmin, Laurel, Rose-Trees, of
 Cherry, Apricock, Peach, Plum, Apple, Pear, and
 Trees of Popler, Pine, Oak, &c.

There are many sorts of Leaves that have no such
 woody Fibres or Veins; as for Instance, Vine and
 Lime-Tree Leaves.

Those

Those of the first Sort above-mentioned, and the like are to be gathered in *June* or *July*, when they are most perfect, not touched by Worms and Caterpillars. They are to be put into an earthen Pot or a wide Glass Vessel, with a good deal of Rain-Water poured over them, and afterwards left in the open Air, uncovered and exposed to the Warmth of the Sun. The Water must always stand above the Leaves, and if it evaporates so as to leave them dry, fresh Water must be poured on. Thus the Leaves begin to putrify; some sorts will be rotten in a Month, others hold out two Months and longer. When the two external Membranes begin to separate, and the green Substance of the Leaf to grow liquid, then it is Time to perform the Operation. The Leaf is to be put into a white and flat earthen Plate or Dish filled with clear Water; then being gently squeezed with the Finger, the Membranes begin to open in the Extremities, and the green Substance comes out. Take the Membranes on both sides dexterously off with the Finger, which must be most carefully done in the middle of the Leaf near the Stalk: If there is once an Opening, the rest follows easily. The Skeleton that remains between, is afterwards washed in clear Water, and kept in a Book.

The Method with relation to Fruit; as Apples, Pears, Plums, Cherries, Peaches and the like, is as follows.

The finest and largest Pears that are soft and not stony, are most proper for this sort of Anatomy. First, they are to be nicely pared without squeezing them, and Care taken not to hurt the Stalk or the Crown. This done, put as many, and of such sorts as you have pitched upon, into a Pot of Rain or fresh Spring-

Spring-Water; cover it, and let them boil gently till they grow thoroughly soft; then take them out and put them into a Vessel of cold Water: The Pear which is to be anatomized, is to be put into a Dish filled with cold Water; then take and hold it by the Stalk with one Hand, and with one Finger and the Thumb of the other Hand, rub the Pulp of the Pear gently off, beginning near the Stalk and rubbing equally towards the Crown, and you will easily see in the Water how the Pulp separates from the Fibres, which being most tender towards the Extremities, it is there the greatest Care is to be taken. No Instrument is of any use in this Operation, except last of all a Penknife to separate the Pulp sticking to the Core. In order to see how the Operation advances, you may sling away the muddy Water from Time to Time, and pour on clean: All being separated, the Skeleton is to be preserved in Spirits of Wine rectified. The same to be observed with relation to Apples, Plums, Peaches and the like.

Turnips and other Roots, that have woody Fibres or Ribs, must be boiled without paring, till they grow soft, and the Pulp comes off. Not only many sorts of Roots, but also the Barks of several Trees may be reduced after this Method into Skeletons, presenting rare and curious Views of Vegetables.

Hence one must acknowledge the inimitable Wonders of the Almighty, how wonderfully he has created every thing, yet so that all Creatures in Nature tend to Corruption. Therefore God having done every thing well, we ought to honour, praise and thank him for his Mercy, Goodness and Kindness, which in his Love he has made Mankind Partakers of.

I have invented the above said Preparation through my own Speculation, and with great Pains, without the Assistance of any Man living: I have made frequent Experiments of it, and do now communicate it very freely and readily.

IV. *An Account of what happened from Thunder in Carmarthenshire; partly had from the Woman's Mouth that suffered by it, partly from what was observed by others, communicated to the Royal Society, by John Eames, F. R. S. as he received it in a Letter from Mr. Evan Davies.*

PENCARREG, Saturday December 6, 1729.
 In the Afternoon of the same Day there happened terrible Thunder and Lightning, which alarmed the whole Neighbourhood; and about four of the Clock of the same Evening, or thereabouts, as the Wife of one *William Griff. Morgan* of the said Parish, was carrying a Pail of Water into the House, being no sooner come over the Threshold into a small Entry that leads towards the Fire, there broke such a violent Clap of Thunder, after its Forerunner (Lightning) that she and three of her Children were very surprizingly struck dead, and instantly bereaved of their Senses, that they lay (they know not how long) miserable and ghostly Monuments of the terrible Shock, being the most dismal Sight that was ever known in those Parts; and I think, by the Report (if my Memory fails me not) they lay weltring in their Blood, before they recovered, and were able to creep to the Bed, till the next Neighbour happened to come in (the Husband being then

then abroad at his Day-Labour) to assist them. The Cause, whatever it was, whether Thunder-Bolt, Thunder-Ball, Lightning, &c. (The Learned are best able to distinguish) struck 'tis imagined) at the East End, near the Foundation, into the Hearth, and cleaved in two a thick Stone of about half a Yard in Breadth beyond the Fire (which we commonly call in *Welsh Pentan*) One Part whereof still remains, and that cleft, but the other is shattered into small Particles and Splinters, and those shot into their Flesh, which 'tis presumed) did the most Hurt. About twenty-four or more of those Stones were from Time to Time taken out of their Wounds; two of those, being all I could get, I have sent for an Instance. To proceed in as regular a Method as possibly I can with the Account, it appears, that afterwards it forced its Way out through the Wall on the South-side within the Compass of the Hearth, when it made a terrible Breach from Top to Bottom, and removed the Stones from the Foundation, and nigh thereto made a deep Hole perpendicular in the Earth, that one might thrust in a Staff to the Wrist, as the Woman herself informed me. That part of the Wall was made up before I viewed the Spot. By the Violence of it, the Brand-Irons and Legs thereof were strained, and by endeavouring to put them to their true Position as before, they were so burnt up, that they fell a-sunder like rusty Iron, or Timber Worm-eaten, and so became of no further Use. The Partitions in the House, which were of no strong Substance (being watted, such as they have in Country Houses) were moved out of place, and a Chest full of Corn forced down towards the Door, some Yards from the Place it stood. The Bucket the Woman had in her

Hand, and other wooden Vessels in the House, were all or most of them shattered, Dishes and Spoons, &c. blown off, and after some Days, found and gathered in the Garden, on the North-side of the House, split and broken, with some Yarn that was hanging in the Top of the House, found out of Doors a while after; and many more Disorders than I am able to account for at present.

WOUNDS *and* BRUISES.

The Woman has quite lost her left Eye, which she perceived herself to be blind of, after she came to herself. The poor Creature was speechless for a Week or nine Days, and could not swallow. She has lately had a few Stones come out from the Roof of the Mouth, under the Tongue, and other Parts inwardly: The Tip of her Tongue taken off, as far as I can guess, for she is still lisping; three of the fore Teeth of the under Jaw broken, with the lower Lip slit, but now pretty well healed; two of the Right-hand Fingers, the Second and Third quite off, and the Colour of that Hand still like a Flame of Fire, as if there were yet remaining some igneous Particles in it. She has a terrible Gash upon that Shoulder between the Joints, that once one might cover an Egg in it, very painful, besides three or more Bruises upon the Arm down to the Wrist, that she is not able to heave or lift it up, without the Help of the other Hand, besides several other Wounds and Bruises over great part of her Body. A Boy (an Idiot) had his Hair all singed, his Face and Breast all scorched with Blisters like Bladders running from the raw Flesh, with several Stones taken out from his Body and Legs, and two other small Children suffer-

ed

ed greatly; so that the Wounds are reckoned by the Woman that used to dress them, to be Thirty at least between the Mother and Children: only one Girl about ten years' old, or thereabouts, that stood at a Distance next the Door escaped, having her Cloaths only singed, and no Hurt done her. I had almost forgot to mention the several Splinters of Bones taken out in dressing their Wounds, that I could not get. It is worth observing also, that they did smell so strong of the Sulphur and bituminous Matter for some Days, that one could hardly go near them. They are now, by the Goodness of God blessing the Means used for their Recovery, free from any grievous Pain to complain of; so that they go about. This is all the Account I can give you, huddled up in some Hast, which may serve till you come yourself and take a more exact Survey.

What Conclusion to draw from hence I know not, tho' some are very forward to pronounce that it was God's Judgment upon them; but as the Ways of Divine Providence are unsearchable, *who causes it to rain upon the just and the unjust*, I think People ought not dive too far into those inscrutable Arcana's; but only pray to God to preserve us evermore, and to avert such heavy Judgments our Sins *may justly deserve, by such or like* terrible Visitations.

This Account was sent me by Mr. Fenkin Fenkins a Clergyman, who lives in that Neighbourhood: About half a Year after I was that Way, and viewed the Breach made in the House, and the Wounds which the Woman and her Children had received by the Stones lodged in their Bodies, some of which were not then healed. The Woman then gave me the little Piece of a Stone, wrapp'd up in the brown Paper, which she

she said she had taken out of her Tongue, above five Months after this Disaster had happened.

Evān Davies.

V. *The Postscript of a Letter from George Martin, M. D. to William Græme, M. D. F. R. S. giving an Account of the Operation of Bronchotomy, as it was performed at St. Andrews.*

P O S T S C R I P T.

I Was called to a young Lad, who being in such a good State of Health, as to be then making a Visit to some of his Comrades in another Street, was all of a sudden taken ill with a violent Trouble in his Throat; in which however, I could see nothing wrong, the *Amygdalæ*, and other Parts in view, being in all Appearance sound enough, but only looking a little drier than ordinary; without any external Tumour appearing about the *Larynx*, and no considerable Frequency or Strength in his Pulse. But he had great Pain and a *Dyspnœa*, with an Impossibility of swallowing either Liquids or Solids; every thing returning forcibly by the Mouth and Nose, when he made an Effort to get it over. From all which I reckoned it an *Angina* of one of the worst Kinds, *sine apparente tumore* (See *Hippocr. Prognost. xxiii. 3. & Prænot. Coac. iii. 96.*) and the Seat of the Disease in the *Larynx*,

rynx and the Fibres common to it, and the Top of the Gullet.

Notwithstanding repeated Bloodings, Blistering betwixt his Shoulders, Cupping, &c. whereof it is needless to give you a particular Detail, the Disease continued so obstinate, and the Patient so like to suffocate, that next Day in the Afternoon his Friends, although very averse in the Morning, when I first proposed the piercing the Windpipe, at length earnestly desired that the Operation might be performed; and the poor Lad bad us try any Experiment to preserve his Life. He had good Reason so to do; for indeed, in all Probability, in a few Hours he would have been strangled to Death most miserably, *constante mente, integrisque sensibus*, as the elegant *Fernelius* (*Patholog.* v. 9.) expresseth it. Whence you see it was not out of an itching Desire of making Experiments, or a wanton Officiousness, that we directly set about the Operation. Which was done with such Success, that in less than four Days, his Breathing being perfectly easy, and his Deglutition being almost so, we removed the *Cannula*, and left the *Glottis* to do its own Office.

According to *Cælius Aurelianus* (*Acut.* iii. 4.) and the Author of the *Liber Introductorius* (cap. 13.) ascribed to *Galen*, *Bronchotomy* was proposed by *Asclepiades* (however inconsistent with his Delicacy, and the rest of his Character, the seeming Harshness of this Operation may appear) and is described and earnestly recommended by almost all the systematical Writers of Surgery from *Paulus of Ægina* (*de re Medic.* vi. 33.) and, as he says, *Antyllus*, and some other of the best Surgeons before him, down to the present Times. But when they are at so much Pains to defend the Reason-

ableness

ableness of it, and when they shew so much Fondness of citing and telling Examples of the healing accidental Wounds of the *Trachea*, without ever mentioning their own regular Performance of the Operation (which would have been a shorter and much more effectual Recommendation of it) when I say, I consider all this, I find myself obliged to think that it has very seldom been reduced to Practice. So rare had it been that *Aretæus*, a Man of vast Judgment and Skill in Diseases (*Cur. Acut.* i. 7.) thought the Operation had never been actually done with Success. And *Cælius Aurelianus* looked on it as an impracticable Whim of *Asclepiades*. Neither *Avenzoar* (*Medic.* i. x. 14.) nor *Albucasis* (*Chirurg.* ii. 43.) knew any of their Countrymen who had undertaken it. And the *Arabs* are reputed to have been hardy enough Surgeons. The most that I know of amongst them of this Kind is in *Avenzoar*, who tried the Experiment on a Goat, and cured the Wound; which shews the Ingeniousness and Industry of the Author. For as to what you will find some Writers telling you, that *Rases* (*Contin.* vii. Fol. m. 77.) saw *Andrusus* the Physician do it (the Copy I looked into, printed at *Venice* 1505, calls him *Ancilifus*: and perhaps it should be *Antyllus* for them both) I think this flows from a mistaken Interpretation of that Author's Meaning. Since you will read the whole Context, I think you will easily perceive that all he says of the Operation is upon hearsay; and consequently, that he had only seen in Books, that such a one had done it. That most accomplished Anatomist and Surgeon *Fabricus ab Aquapendente* (*Operat. Chirurg.* xlv. p. 477.) frankly acknowledges, that neither he nor any of his Contemporaries had ever ventured

to perform it. Neither does his Successor in the Profession of Surgery, and his Rival in Anatomy, *Julius Casserius* of *Placentia* (*De Voc. Org.* i. 20.) pretend to have done it ; though he has endeavoured to illustrate the Operation by some very neat Figures ; which you will not readily suspect to be from any but dead Bodies. And next to him *M. Aurelius Severinus* (*Chirurg. Effic.* ii. 40.) who was a very judicious and learned Man, and the best and boldest Surgeon of his Time ; though he recommends it with a great deal of Warmth and Keeness, yet it seems, even in his latter Days, he never had Occasion to try it : So that the first undoubted and distinctly recorded History I can find of this Operation being actually practised, is in the learned *Anton. Musa Brasavolus* (*Com. in Hippocr. de Diet. in acut.* iv. 35.) who performed it in a desperate Squinace, when the Surgeon refused to do it ; and repeated it again in the like Case. Mr. *Arnaud* the Frenchman did it ; but his Patient died (*See Garengot Operat. Chirurg.* xxxi. p. 489.) However, his Countryman Mr. *Binard* had better Success (*Garengot ibid.* xxxii. p. 498.) Dr. *Freind* (*Hist. Phys.* l. p. 206.) cites *Purman* doing it : and (*p.* 207.) tells us of another Case communicated to him by a Surgeon whom he does not name. And besides these, I believe there are but few Instances can be produced, of any who really performed the Operation on a living Person. I hear now that Mr. *Baxter*, a Surgeon in *Coupar* of *Fife*, not far from us, and Dr. *Oliphant* in *Gask* in *Perthshire*, did it with very good Success within these few Years.

In the actual Performance of the Operation they certainly did, or might have observed some things omitted by Authors, and even some not perfectly agreeing with the common Accounts that are given of it. I think it

worth while to notice that in the very cutting, before we got a free Aperture into the *Trachea*, and the Pipe introduced, the Patient felt some Relief; which I thought might be ascribed to the Effusion of Blood in the Operation; a small Quantity whereof evacuated so near, the Part affected could not, according to the true Laws of *Hydraulicks*, and the Observations and Practice of the Ancients (however disagreeing with *Bellini's Theory*) but make a more considerable Revulsion, than a much greater taken away at a great Distance. Whence the judicious *Fab. ab Aquapendente* (p. 480.) with very good Reason supposed that by the Derivation here, the Patient would be more apt to feel some Relief than Trouble. Which *Julius Gualtavinus* too made no Doubt of in his Dispute upon this Subject against *Aretæus* (See *M. Aur. Severin.* p. 103.) And now their Supposition and Conjecture is confirmed by Experience. And since there continued a greater Flux of Blood to the Wound while it was suppurating, I reckoned the Circulation in the Muscles of the *Larynx* to be with less Force than ordinary, and so probably to contribute to the diminishing the Strength of the Voice, which for a good many Days after the Operation, was observed to be much weaker than it used to be. Which I all along thought was rather owing to this, and the Lowness of his Body by his slender Diet, &c. than to any Hurt of the recurrent Nerves; which being cut, do indeed destroy the Voice, but by their Deepness, are in less Hazard than some in old Times used to think.

In doing the Operation on a living Person, one cannot but remark at the very first, that the *Cannula* should not be made near so short as is ordinarily proposed

posed in Books and chirurgical Lectures: For we found that upon cutting the Parts, especially the *Thyroid Gland* (which is not so much minded in most of the common Descriptions of this Operation as should be) soon become so much tumified, that it will require a Pipe above an Inch long, to penetrate sufficiently into the *Aspera Arteria*. Which is more than double of *Garangent's* Allowance of six Lines; who is one of the recentest Writers, and has communicated to us all the Surgery the *French* are Masters of. The Leaden Pipe we had prepared not answering the Design, that which we made use of was too long and too small, being the common *Cannula* for tapping in the Dropsy, fluted a little at the End, and hindered by a very thick Compress, perforated in the Middle, from penetrating too deep into the *Trachea*.

The mucous Particles and Steams arising from the Lungs, made a constant weeping of a thin slavery Liquor from the Mouth of the Pipe, part whereof thickening, and stuffing its Cavity, sometimes very much incommoded the Patient's Respiration by it, so as to render it necessary to have it taken out and cleaned. And hence, when some Moderns very precisely bid us put a thin Slice of Sponge, or a bit of Muslin, &c. close over the Orifice of the *Cannula*, to prevent the Ingress of Dust, Downs, or the like, into the Lungs, it confirms what I said before of the Unusualness of the Operation, and looks as if they had only contemplated the Matter in *Abstracto*, as the *Metaphysicians* say, without considering they had not to do with a pure thin dry Air, but with a heterogeneous Fluid, that is moistened and thickened with viscid Particles, which are apt to run together in stiff Concretions. And therefore, though

it must be acknowledged that there would have been less Hazard of a Stoppage, if our *Cannula* had been shorter, and wider, especially at the Mouth, I cannot but think it an ingenious Proposal of one of our Ministers here, to make the Pipe double, or one within another; that the Innermost might safely and easily be taken out and cleaned when necessary, without any Molestation to the Patient: For it is no small Trouble to him to be obliged to have the Bandage frequently removed, and the Pipe fitted a-new to the Orifice made in the *Trachea*.

And indeed we found no Inconvenience in our Patient's breathing the Air as it passed through the Pipe, without any cleansing or intercepting *Medium*, though the House was none of the cleanest, being an ordinary *Tradesman's* here. But if by a larger, and consequently a more patent Tube, one, especially of more delicate and ticklish Lungs, should be incommoded that Way, I think the Access of Dust, &c. might conveniently enough be hindered by a Piece of Muslin, or thin Hair-Crape, tied slackly about the Neck over the Orifice of the *Cannula*, so however as not to touch it, or to be wetted by the Liquor coming from it.

The Patient was soon perfectly recovered: He breaths, speaks, eats, drinks, and performs all the other Offices of Life, and goes about his Calling as formerly. And now I cannot but notice the needless Pain some Writers are in about healing up the Wound by Bandaging, Sticking, &c. For we found it easily to fill up of itself in a very few Days, by only dressing it every other Day or so with a soft Tent, made less and less every Dressing, and armed in the common Way with *Liniment. Arcei*. I believe indeed it
would

would have taken a little more Time to heal, if our Patient had been older.

Having, as you will easily perceive, omitted those things that were common or of less Moment, I have set down what seemed most remarkable in the Course of this Operation. Upon which Subject I should not have had so much to say if this elegant Method of rescuing one from imminent Danger, and the most difficult kind of Death, had not been ordinarily described more from Theory and Fancy than from Nature and Practice : And if Surgeons had been accustomed to be half as bold to assist Nature in such an Extremity as both they and many Physicians are sometimes officious to disturb her regular and salutary Steps.

VI. Observationes Cœlestes multifariæ, *Annis*
1728 & 1729. Pekini in Sinis habitæ, &
ad Rev. P. Johannem Baptistam Carbone,
Soc. Jes. transmissæ; ex ejusdem Cl. Viri E-
pistola ad Jacobum de Castro Sarmento,
M. D. Col. Med. Lond. Lic. & R. S. S.

Congressus Lunæ cum aliquot stellis observati Pekinæ
à Nov. 1728, usque ad Nov. anni 1729.

NOT. die 20 5^h 0' 42'' mane Luna obtexit stel-
 lam *v* *Leonis* locus immersionis erat proxime con-
 tra Roccam.

6^h 21' 55'' prodiens Stella stabat in recta cum Rei-
 noldo & Grimaldo; adeoque locus emersionis prope
 Berosum, & transitus ferme centralis.

Dec.

Dec. die 6. vesperi Conjunctio *Saturni* cum *Luna*, sed *Luna* non nisi post $7^h \frac{1}{4}$ è nubibus promicante, Cap-
tæ sunt tantum sequentes distantie *Saturni* à propiore
limbo *Lunæ* cujus diameter $30' 45''$.

Hora 7	18	} diff.	$\left\{ \begin{array}{ll} 17' & 55'' \\ 20 & 30 \\ 23 & 0 \\ 25 & 10 \end{array} \right\}$	$\left\{ \begin{array}{l} \text{in recta} \\ \text{ex cuspide} \\ \text{bor. } \epsilon \text{ per} \end{array} \right\}$	$\left\{ \begin{array}{l} \text{Fracastorem.} \\ \text{Ifigdorum.} \\ \text{Sintbecium.} \\ \text{Petavium.} \end{array} \right\}$
	25				
	33				
	40				

1729. *Mart.* die 8. $11^h 18'$ P. M. *Luna* obtexit stel-
lum boreo-orientalem trapezii, quod est infra pedes au-
rigæ. $12^h 12'$ emerfit stella è regione *Messallæ*. Die
 $11. 7^h 56' 30''$ vesp. *Luna* obtexit stellam *n Cancri*
Locus immersionis erat contra *Schikardum*. Emerfit,
quæ fuit contra *Petavium*, paulo tardius notata est
 $9^h 2' 30''$ accideret autem proxime $8^h 59'$.

April. die 2. vesp. Conjunctio *Lunæ* cum *Pleiadi-*
bus.

$8^h 23' 2''$ *Luna* obtexit stellulam borealiorem trian-
guli quasi æquilateri, quod præcedit *Pleiadas*: Locus
immersionis contra *Phocyllidem*. $9^h 2' 23''$ absorbit
stellam claram, quæ est supra *Pleiadas* ferme in recta
linea cum *Taygeta* & *Elestra*: Locus immersionis vi-
debatur esse contra *Cardanum*. $9^h 9' 25''$ *Luna* obtexit
Taygetam, cujus immersio erat contra *Gibæum* prope
cuspide *Lunæ* australem. $9^h 18' 58''$ immersa est præ-
cedens *Asteropes*, contra *Bartolum*. $9^h 25' 27''$ immersa
est sequens prope *Casatum*. Emerfiones non poterant
videri ob nimiam undulationem lucidi limbi *Lunæ* at-
mosphæram subeuntis.

Die 11. $8^h 12'$ P. M. *Luna* obtexit stellam *Leonis*
directe contra *Schikardum*, stante *Messalla* in vertice
Lunæ. Emerfit Stella $9^h 11' 30''$ paulo infra *Langre-*
num, verticem *Lunæ* obtinente *Mercurio*.

Nov. die 7. manè transitus Lunæ per *Pleiadas*, cum borealium occultatione, ut sequitur.

H	'	"	
4	51	10	Immersit <i>Celæno</i> contra Zucchium.
4	53	6	Immersit <i>Faygeta</i> contra Crugerum.
5	17	30	Immersit <i>clara</i> Asteropes supra Ricciol.
5	18	20	Immersit <i>Maja</i> contra marg. occ. Schi- kardi.
dub. 5	21		Immersit <i>sequens</i> Asteropen contra Roc- cam.
5	37	10	Emersit <i>Celæno</i> recta contra Petavium.
6	2	20	Emersit <i>Faygeta</i> inter Langrenum, & mare Crisium.

6 15 30 Emersit *Maja* ad bor. Wendelini.

Emersio *Asteropes* ob diluculum nequit videri.

Eodem die vesp. 7^h 30' 34" ab Luna occultata fuit
 ✕ *Tauri* paulo infra Galilæum, quæ rursus emerfit
 8^h 33' 15" paulo supra Langrenum.

*Immersiones & Emersiones Satellitum Jovis in, &
 hujus ex umbra ibidem observatæ.*

<i>Immersiones</i> SATELL. I.					
1728. D.	H.	'	"		
Nov. 5	1	42	45	manè.	
	12	3	36	15	manè.
	13	10	4	10	vesp.
	19	5	28	20	manè.
	20	11	55	56	vesp.
	28	1	47	50	manè.
	29	8	16	35	vesp.
Dec. 6	10	8	0	vesp.	
	12	5	30	45	manè.
	15	6	27	0	vesp.
	22	8	17	0	vesp.

Emer-

Emerfiones SATELL. I.

D. H. ' "

1728.	Dec.	31	6	50	15	vefp.
1729.	Jan.	7	8	40	40	vefp.
		16	5	0	0	vefp.
		22	0	24	10	manè.
		23	6	52	20	vefp.
		30	8	46	15	vefp.
	Feb.	15	7	5	0	vefp.
	Mart.	10	7	21	40	vefp.
		17	9	19	50	vefp.
		24	11	16	15	vefp.

Immerfiones SATELL. I.

Nov.	1	2	58	45	manè.
	15	6	45	0	manè.
	17	1	13	15	manè.

iones SATELL. II.

Nov.	6	6	8	45	manè.
Dec.	1	3	3	20	manè.
	8	5	35	55	manè.
	18	9	25	0	vefp.

Emerfiones SATELL. II.

Jan.	2	5	21	30	manè.
	5	6	37	0	vefp.
	19	11	44	15	vefp.
	27	2	20	0	manè.

Feb.

(. 459)

	D.	H.	'	"	
<i>Feb.</i>	6	6	14	18	vesp.
	13	8	49	0	vesp.
	20	11	28	45	vesp.
<i>Mart.</i>	10	6	9	0	vesp.
	17	8	49	40	vesp.
	24	11	30	10	vesp.
<i>Maii</i>	20	8	49	30	vesp.

Immerfiones SATELL. II.

Nov. 17 11 52 25 vesp.

Immerfiones SATELL. III.

1728.	D.	H.	'	"	
<i>Nov.</i>	6	10	4	10	vesp. disparuit plenè immer- fus in umbram.
	7	0	47	15	manè cœpit rursus emer- gere.
	21	6	1	5	manè plenè immerfus fuit.
	24	5	24	20	vesp. plenè disparuit in um- bra.
1729. { <i>Jan.</i> {	24	82	1	40	vesp. denuò cœpit promicare.
	31	9	25	36	vesp. integrè immerfus fuit.
<i>Feb.</i>	1	0	21	0	manè rursus prodire cœpit.
<i>Mart.</i>	15	9	33	0	vesp. plene immerfus in um- bram.

1729. *Immerfiones* SATELL. IV.

<i>Jan.</i>	16	6	30	0	vesp. circiter, ingressus est umbram.
	16	9	24	0	vesp. cœpit rursus sensim e- micare.
<i>Mart.</i>	24	6	46	20	vesp. plenè disparuit in um- bra.
	24	10	10	20	vesp. denuò promicare cœpit.

Q q q

Observatio

*Observatio eclipsis Lunæ totalis habita in publico
Observatorio Pekinenſi A. C. 1729. die 14 Fe-
bruarii horis matutinis.*

Tota illa nocte continenter modicè ningeſbat, cœlo
tamen ſic tenuiter nubilato, ut Lunares maculæ ſæ-
pius utcunq; diſtingui poſſent; quanquam rarius ac
difficilius tempore immerſionis: Sub emerſionem enim
paulatim cœlum ſerenatum fuit, ut circa finem jam pe-
nitus innube exiſteret.

Horologium correctum fuit per altitudines Arcturi &
aquilæ, item ex culminante Spica *Virginis* ac Lance
borea *Libræ*. Diameter Lunæ initio eclipsis micrometro
dimenſa, erat 32' 0". Erantque in linea verticali cum
centro Lunæ Pythagoras & Helicon.

H.	'	"	
2	38	30	Initium eclipsis contra Heveli- um.
41	0		Grimaldum.
42	30		Qui totus immerſit.
43	0		Galilæum.
47	0		Ariſtarchum.
	30	Umb. ad	Keplerum.
50	0		Gaffendū.
58	0		Copernicum.
3	30		Sinum æſtuum orientaliorem,
9	0		Tychonem.
17	30		Menelaum.
24	30		Poſſidonius totus in Umbra.
26	0		Fracaſtorem.
31	0	Umb. ad	Proclum.
32	0		Mare Criſium.
			Umb.

H.	'	"	
3	35	30	Umb. ad Langrenum.
	39	0	Immersio totalis inter Langrenum, & mare Crisium.
5	17	10	Emerfio prima lucis infra Grimaldum.
	21	0	Grimaldus prodire incipit.
	22	25	Totus emerfit.
	28	0	Emerfit Gassendus.
	30	35	Kepplerus.
	36	40	Umbra per centrum Tychonis.
	37	20	Totus prodiit.
	40	35	Prodiit Copernicus.
	46	28	Plato incipit emergere.
	48	30	Totus detegitur.
	50	0	¶ Sinus æstuum.
	53	50	Architas.
	55	20	Manilius.
	57	15	Emerfère Aristoteles.
	58	45	Menelaus.
	59	10	Ariadæus.
6	0	50	¶ Fracastor.
	2	30	Restat in umbra diametri Lunæ.
	2	50	Plinius.
	5	45	¶ Possidon. Vitruv. & Cenforinus.
	10	0	Prodeunt } Taruntius.
	10	30	} Proclus.
	13	10	Langrenus totus detectus.
	13	30	Mare Crisium incipit emergere.
	16	30	Totum prodiit.
6	17	40	Finis eclipsis contra mare Crisium, existente tum in linea verticali per centrum Lunæ Oenopide ac Heraclide.

VII. *Nova Literaria Physico-Medica curiosa; containing a Description of the Cereus which flowered at Norimberg in the Year 1730. Communicated by Jo. Georg Steigertahl Arch. Reg. Hanov. Prof. Helm. Soc. Honorar. Coll. Med. Lond. & R. S. S. to Sir Hans Sloane Bart. Pr. R. S. & Coll. Med. Lond. Translated from the Latin by T. Stack, M. D.*

THE *Cereus Peruvianus* happened lately to flower at *Norimberg*, in the Garden of Mr. *John Magnus Volckammer*, who is well known to the World by his *Hesperides Norimbergenfes*. Upon this Occasion Dr. *Christopher James Trew* made use of all possible Care and Industry to acquire a thorough Knowledge of this Plant. Wherefore we will compendiously communicate his Observations at present, waiting his own giving an ample Account thereof, with Copper Plates, such as he has some Years since given of the *American Aloe* with the utmost Accuracy and Diligence.

This *Cereus*, separated from another, of which it was a Branch seven Years ago, and exposed in open Air all Summer, grew without pushing forth Branches. It is six Foot three Inches high, and thirteen Inches thick. It has seven Angles at its Basis, eight about the Middle, and nine near the Top. Its upper Part is of a Sea-Green, on Account of the Powder with which it is covered; its lower of a Grass-green. The Down of its Prickles is between Pale and White about the Top, every where else it is Brown. On the fifth of September,

September, at the Height of six Foot two Inches from the Ground, it shot a certain round Knot from its Trunk, which without any help of Art, so encreased and extended almost horizontally, that on the fourteenth of the same Month, it was eight Inches long, and plainly shewed a Flower, though as yet closed, embellished with a beautiful Mixture of Green, Purple, and White. This same Evening the Flower began to open, and continued till Midnight; when being entirely spread, it was six Inches in Diameter. It was of a pretty strong, but not very pleasant Smell. After Midnight it gradually contracted about half an Inch, and remained thus till next Day at Noon. Then it began to contract faster, to half the Diameter the expanded Flower was of; and the next Morning it was quite closed and withered, but hung on the Trunk till the thirtieth of *September*. The Beginning of the Flower is a sort of Tube three Inches long, not quite an Inch thick, between a yellow and a pale Green. Its Surface was smooth, but chanelled by certain small narrow Furrows, between which, blunt Protuberances were seen to run, in a parallel Order, along the Ridges. Where the Tube expanded itself, it divided into more than forty petaloid Segments, ranked in six separate Series, the three inferior and exterior whereof here and there confounded their Order, while the three superior and interior remained regular and unmixed. These Series were distinguished by their Size and Colour. The first, or exterior was of the same Colour with the Tube, *viz.* of a pale Green; but its upper Part gradually inclined to a Purple. The second and third had half the inner Part greenish, the Edges of a more intense Purple. The fourth was between yellow

low and white, terminating in purple Tops. The Tops of the fifth were likewise purplish. The petaloid Segments of the sixth were very tender and white. The Segments are of an oblong Figure, and in the first Series were terminated with blunt, in the others, with more and more pointed Tops. The inner or sixth Series, which contained thirteen of these Segments, exhibited all the Edges finely and lightly, but irregularly cut and divided. The *Pistillum* of equal Height with the Surface of the Flower, and hollow like a small Tube, ran, at its upper End, into as many fine pale Filaments, spread in the Form of a Crown, as there were Segments in the inmost Row, viz. thirteen. The Day before the Flower dropped from the *Ovarium*, the Place where it was to separate was marked by a blackish Circle, at which the Tube separated spontaneously from the *Ovarium* or *Matrix*, that is, the Rudiments of the Fruit; the *Pistillum* still firmly adhering to the *Ovarium*. The Flower, now fallen, being dissected longitudinally, the Origin of the *Stamina* lay open to the Eye; and it very manifestly appeared that the petaloid Segments of the Flower, far from affording the least Mark of a natural Partition, stuck so very close to the Tube, that not one of them would quit it without tearing it off by Violence.

The Fruit, though it came not to its full Growth, plainly evinced, by Inspection alone, that it is not prickly. Upon Dissection it afforded a viscous Juice, and within was a certain Cavity, the Sides whereof were every where, except at the Bottom, thick set with an innumerable Quantity of small *Villi*,

to each one of which hung an oblong, white, pellucid Vesicle, which is the Rudiment of the future Seed.

We hope this Description will not be unacceptable to Lovers of Botany, not only because the *Cereus* does not often flower, nor are there always at hand Persons either able, or willing to give the Attendance requisite for rightly observing and describing so transient a Flower: But also because it plainly discovers the Errors committed, even by very great Men, in the Description of this Plant and its Flower. The Groffest of these Errors, doubtless, is their ranking it unanimously among the polypetalous Flowers, whereas it is monopetalous. But as for other Remarks, which our most diligent Author has furnished us with, for correcting the History of this Plant, we will, for want of Room, refer to the next Opportunity.

Pl. 20.

1730.

F I N I S.

ERRATA in the Thirty-sixth Volume of *Philosophic. Transactions.*

- N**^O. 407. p. 7. l. 22. read *successively*.
 409. p. 107. for *oen* read *een*, f. *nyt* r. *uyt*.
 410. p. 139. l. 17. f. *credor* r. *credo*.
 410. p. 146. l. 12. f. *venticulus* r. *ventriculus*.
 ib. l. 22. f. *tns.* r. *tus*.
 ib. l. 22. f. *continentur* r. *continenter*.
 p. 150. l. 18. f. *proxinantes* r. *propinantes*.
 p. 153. l. 1. f. *Cautis* r. *Caulis*.
 411. p. 211. l. 5. f. *Wisp* r. *Whisp*.
 413. p. 259. l. 18. f. *Orificis* r. *Orificio*.
 414. p. 345. l. 4. from the Bottom, f. *Acites* r. *Ascites*.
 p. 346. l. 6. from the Bottom, *the same*.
 p. 356. l. 3. f. *unlike* r. *unlikely*.
 415. p. 434. *vide Errata*.
 p. 378. l. 5. f. *villoso*, you may read *hirsuto*, the Word *villoso*,
 being used in the Original Description, and *hirsuto* in the
 Title of the original Picture of the Plant.
 416. p. 441. l. 5. from the Bottom, r. *Apple, and Pear-trees, of*
 Poplar, &c.
 p. 452. l. 6. dele the , between *near* and *the Part, &c.*

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